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THE PNEUMO-ENCEPHALOGRAPHIC APPEARANCE OF HEMANGIOBLASTOMA OF THE CEREBELLUM*

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INTRODUCTION

THE pneumo-encephalographic diagnosis of intracranial tumors in the past has been limited with few exceptions[1,2,3,4,5] to the localization of the lesions. However, with increasing knowledge of the growth characteristics of these tumors, it is becoming evident that many of them produce distinctive alterations in the pneumo-encephalograms which make it possible to recognize the pathologic nature of the space-occupying mass. Another example of a specific histological tumor type in a specific location presenting characteristic changes in the pneumoroentgenograms is the hemangioblastoma of the cerebellum. A group of 13 cases of this type of tumor with the distinctive pneumo-encephalographic changes is described in the present communication.

HISTORY

In 1926 Lindau[6] described the occurrence of hemangioblastic tumors of the cerebellum, consisting in each case of a large cyst with a small mural nodule of solid tumor. This was the first recognition of these tumors as a separate group. Previously they had been considered as unclassified vascular gliomas with cysts, sarcomas, cystosarcomas, endothelial sarcomas or peritheliomas. Some of these tumors, Lindau was able to show, were associated with angiomatosis of the retina, and cystic and other tumors involving many organs of the body. This combination of cerebellar hemangioblastoma, angiomatosis of the retina, and tumors elsewhere has since received the eponym of Lindau's disease.

Lindau's discovery occurred about the time Bailey and Cushing were preparing their classification of the gliomas, during the course of which they re-examined the cystic tumors of the cerebellum. In the light of Lindau's work they discovered 11 hemangioblastomas which previously had been unclassified. These were included in their monograph[7] on "Tumors Arising from the Blood Vessels of the Brain."

In Cushing's series of 2,023 verified brain tumors (1932), 25 cases of hemangioblastoma of the cerebellum were encountered. In the Neurological Institute in the past ten years (1929–1939), 13 hemangioblastomas of the cerebellum were verified. Our concern with these tumors is only with those in which pneumo-encephalographic studies were made. Of these there were 8 verified cases until August 1, 1937, since when 5 additional cases have been dis-

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closed. Thus it would appear that the recognition of this type of tumor has occurred more frequently in the last few years since its histological nature has been clarified.

CONSIDERATION OF MATERIAL

All of the 13 cases had ventriculograms and in 2 cases encephalograms also were made. The large number of cases requiring pneumoroentgenograms bears out the clinical impression that patients with this lesion often present insufficient clinical signs for the localization of the tumor. This may be due to their benign character and unusually slow growth. The patients all were adults, with the exception of a seventeen year old boy. The oldest patient was fifty-four years and the average age was 35.7 years. In 11 of Cushing's cases the average age was 33.8 years, and in 15 of Lindau's cases the average age was 37.4 years. The distribution of these tumors between the sexes was 8 males and 5 females in our series, 8 males and 3 females in Cushing's series and 9 males and 6 females in Lindau's series, indicating that there is probably some predominance of these tumors in members of the male sex (64 per cent).

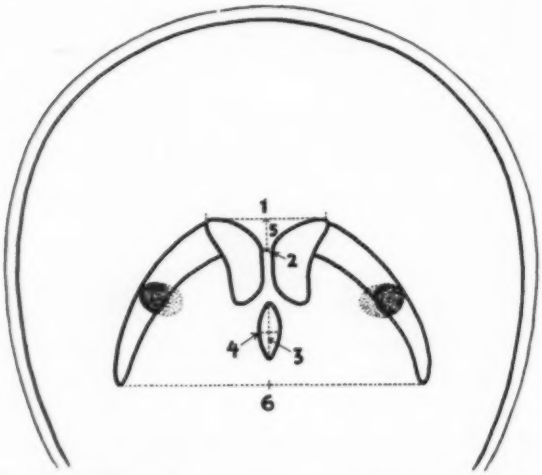

Fig. 1. Schematic representation of normal anteroposterior and posteroanterior encephalograms (see Table 1).

Plain Films of the Skull. The plain roentgenograms of the skull showed only 4 cases to have increased convolutional atrophy, in 3 of which it was mild and in 1 case moderate in degree. The sella turcica was normal in size in all but 2 cases in which it was slightly enlarged. Atrophy of the posterior clinoid processes was present in 7 cases; of the dorsum sellae in 8 cases and of the floor of the sella turcica in 4 cases. In only 1 case was the atrophy present to a marked degree. In the others it was slight. Four patients showed no atrophy of any of these structures. There was no separation of the cranial sutures in any of the cases as might have been expected from the patients' ages.

The pineal gland was visible in 12 of the 13 cases, and was in its normal position in 10 of them. In 2 it was displaced slightly posteriorly. This displacement was 2 mm. and 1 mm. respectively and was misleading and could not be explained. Calcification was not seen in the tumor in any of the cases.

Pneumo-encephalograms. For purposes of comparison of the changes produced in the pneumo-encephalograms by the cerebellar hemangioblastoma with the location of cerebral structures as seen in the normal encephalogram, attention is here called to a series of standard measurements illustrated by Figures 1 and 2.

Table I

MEASUREMENTS IN NORMAL PNEUMO-ENCEPHALOGRAMS

	Minimum	Maximum	Average
1	3.5 cm.	4.5 cm.	4.0 cm.
2	0.2 cm.	0.3 cm.	0.25 cm.
3	2.3 cm.	3.4 cm.	2.7 cm.
4	0.2 cm.	0.8 cm.	0.5 cm.
5	0.3 cm.	0.7 cm.	0.5 cm.
6	7.5 cm.	10.0 cm.	9.0 cm.

Figure 1 represents schematically the combined anteroposterior and posteroanterior encephalograms. The normal measurements for the distances indicated by the Arabic numerals are as follows (Table 1), with a 30 inch target-film distance.

Figure 2 represents schematically a

lateral encephalogram, and the normal distances indicated by the letters as shown in Table II are:

Table II

	Minimum	Maximum	Average
A	1.10 cm.	1.60 cm.	1.42 cm.
B	0.10 cm.	0.20 cm.	0.15 cm.
C	3.0 cm.	3.9 cm.	3.44 cm.
D	1.0 cm.	1.9 cm.	1.46 cm.
E	3.0 cm.	4.0 cm.	3.26 cm.
F	3.3 cm.	4.0 cm.	3.61 cm.
G	0.5 cm.	1.2 cm.	0.82 cm.

The lateral ventricles in the hemangioblastoma series were moderately enlarged. The average No. 1 measurement was 5.87 cm. The maximum No. 1 measurement was 7.2 cm. and the minimum measurement was 5.2 cm. In these cases the hydrocephalus was not great in spite of the long duration of the illness. This is probably due to the very slow growth of the tumor, its location in the cerebellum and its cystic nature, producing an incomplete obstruction and only moderate interference with the egress of the cerebrospinal fluid from the ventricular system. Examining the lateral ventricles individually it was noted that the degree of dilatation of the two ventricles was unequal with the exception of only 3 cases. This is contrary to the general conception that in cerebellar tumors the lateral ventricles are symmetrically enlarged. The difference in the size of the two ventricles varied between 0.1 cm. and as much as 1.8 cm. In the latter instance the right lateral ventricle measured 3.5 cm. and the left, 1.7 cm. With the exception of this case in which the right ventricle was markedly larger than the left, in the majority of cases the left ventricle was larger than the right. Even including this case, the average size of the right ventricle was 2.84 cm. and the average size of the left lateral ventricle was 2.89 cm.

Measurement No. 5 could be made on all 13 cases of hemangioblastoma and was 0.89 cm. Measurement No. 6 averaged 10.40 cm. in 12 cases. Measurement No. 2 averaged

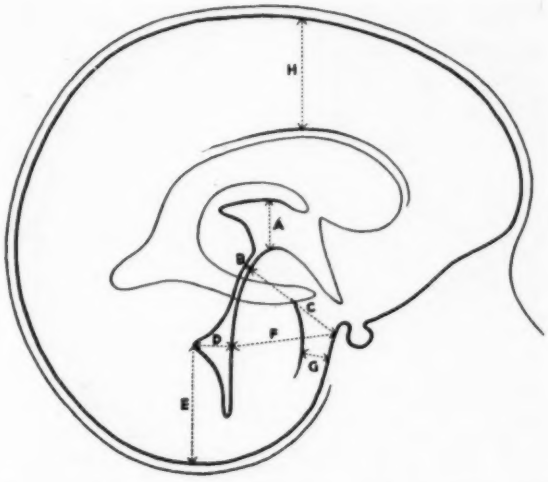

Fig. 2. Schematic representation of normal lateral encephalogram (see Table II).

0.14 cm. The foramen of Monro was seen in 10 of the hemangioblastoma cases and was moderately dilated in all of them. The third ventricle was enlarged in the entire

Fig. 3. Roentgen Ray No. 26280. Anteroposterior horizontal ventriculogram showing moderate enlargement of the lateral and third ventricles.

Fig. 4. Same case as seen in Figure 3. Lateral horizontal ventriculogram showing moderate dilatation and rostral bending of the caudal half of the aqueduct of Sylvius (arrows) and narrow cisterna pontis (arrow).

series. The average vertical measurement (No. 3) was 3.38 cm. The width of the third ventricle, however (measurement No. 4), averaged 1.89 cm. The prepineal ventrodorsal diameter (measurement A, Fig. 2) could be measured in 7 of the 8 cases and averaged 1.59 cm.

The most striking abnormality seen in the hemangioblastoma series was in the aqueduct of Sylvius. It was visible in 11 of the 13 cases, in 10 of which it was displaced rostrally and bent sharply on itself. Usually the distal portion was not visualized and the visible proximal portion was dilated to an average width of 0.4 cm. (measurement B). The distance from the aqueduct of Sylvius to the dorsum sellae (measurement C) averaged 3.0 cm. which was a distinctly shorter measurement than the average normal for this distance.

The fourth ventricle was visible in only 3 of the cases, in 2 of which it was compressed and grossly displaced rostrally. In the third case, in which the tumor apparently originated in the inferior end of the vermis, the exits from the fourth ventricle were obstructed, and this cavity was considerably dilated and displaced upward. The measurements dealing with the fourth ventricle in these 3 cases respectively were:

Measurement	D	E	F
	0.5 cm.	3.5 cm.	2.6 cm.
	1.1	3.4	2.8
	2.7	3.9	3.0

The subarachnoid cisterns were frequently visualized in spite of the fact that the gas was put directly into the ventricles. The cisterna chiasmatis was seen in 5 cases and appeared normal. The cisterna interpeduncularis was visible 8 times and likewise was normally formed. The cisterna ambiens was seen in only 5 cases. The cisterna pontis was visualized in 9 cases and was narrow in 8 of them. The average measurement from the dorsum sellae to the anterior margin of the pons varolii (measurement G) was 0.29 cm. The maximum

Fig. 5. Roentgen Ray No. 35484. Lateral horizontal ventriculogram showing moderate dilatation and rostral curving of the caudal portion of the aqueduct of Sylvius (arrows).

measurement in this group was 0.7 cm. and the minimum was 0.1 cm. In 1 case the cisterna magna was visualized and appeared definitely flattened (Fig. 6).

In 4 cases, 2 encephalograms and 2 ventriculograms, gas was present in the cervical portion of the spinal canal and was cut off sharply at the atlas, as illustrated in Figure 6. The interruption of the column of gas at the level of the atlas is probably brought about by the projection of the cerebellar tonsils through the foramen magnum and not by the lower limits of the tumor. The presence of the gas in the upper cervical region in the encephalogram is easy to understand in view of the fact that it is injected into the lumbar subarachnoid space with the patient erect and is prevented from entering the intracranial cavity by the obstruction at the atlas. In the ventriculograms which had gas obstructed opposite the atlas, the probable explanation is that the gas escaped from the ventricles into the subarachnoid space as has been frequently observed by the presence of gas in the subarachnoid cisterns. This may take place through either the foramina of Luschka and Magendie or back through the needle tract. Indeed in one of these cases the needle tract was visualized by gas within it. From here it easily extends into the spinal subarachnoid space during the manipulation of the patient while making the horizontal series of roentgenograms. Then when the patient is placed in the erect posture, the gas already present in the spinal canal is trapped by the tonsils of the cerebellum projecting into the foramen magnum.

In 2 cases there were hematomas of the glomus of the choroid plexus on the side of the ventricular puncture (right) as indicated by the enlargement of the shadow normally produced by this part of the choroid plexus.[4]

Cerebral sulci were seen in 5 cases. The most commonly visualized sulci were the callosal and cingulate. Only in one ventriculogram and one encephalogram were many sulci noted on the convexity of the brain. These appeared normal. No cerebellar sulci were visualized.

Fig. 6. Roentgen Ray No. 25083. Lateral encephalogram showing narrowing of the cisterna pontis (arrow), and cutting off of the gas in the spinal portion of the cisterna magna (*A* arrows). Gas in cisterna magna over the cerebellum has a straight margin rostrally (*B* arrows).

DISCUSSION

It is generally accepted that in cases of tumor of the cerebellum there is usually present a certain degree of internal hydrocephalus involving all the intracerebral cavities rostral to the site of the tumor. This is also true of hemangioblastomas of the cerebellum. We wish to emphasize that the degree of dilatation of the two lateral ventricles is usually asymmetrical as shown in the present study and in unpublished data in other cerebellar tumors. The explanation for the unequal dilatation of the lateral ventricles has not been determined. However, its recognition is of practical importance since it disproves the previous belief that infratentorial tumors invariably produce symmetrical enlargement of the lateral ventricles.

The third ventricle was moderately enlarged and not displaced in the hemangio-

FIG. 7. Same case as seen in Figure 6. Lateral ventriculogram showing rostral bending and moderate dilatation of the caudal half of the aqueduct of Sylvius (arrow).

blastoma series, thus offering no changes that could be considered distinctive for this lesion.

As has already been stated, the characteristic diagnostic features to be noted in the pneumo-encephalogram in hemangioblastoma of the cerebellum are the dilatation and rostral bending of the caudal half of the aqueduct of Sylvius, the marked narrowing of the cisterna pontis and the usual absence or marked compression of the fourth ventricle. The changes in all three of these spaces, it is our belief, are due to the position which this tumor usually occupies in relation to them. We believe that in order for a tumor to produce these distinctive changes in the above-named cerebrospinal fluid spaces, it must be primarily located, if in the vermis, either in the region of the declive or superior to it, or if in the lateral hemispheres of the cerebellum, it must occupy a correspondingly superior position. It is only such a location that can account for these deformities. Were the tumor frequently located in the inferior portion of the cerebellum, the picture presented would resemble the only case in the series in which there was considerable dilatation of the fourth ventricle with upward displacement of this cavity, and in which the tumor at operation actually extended partially through the foramen magnum. Moreover the superior location of the tumor must account for the difficulty, often actually insuperable, in disclosing the lesion at a primary operation. Thus in this series of 13 cases, the surgeon failed to disclose the lesion in 4 instances at an initial operation in spite of the definite diagnosis of cerebellar tumor from the pneumo-encephalograms, and in which at a later operation a hemangioblastoma was readily found and removed. This would indicate that a suboccipital decompression permits the tumor to migrate caudally in the direction of the bony defect, presumably because of lessened resistance. Indeed this has led one of us in some cases

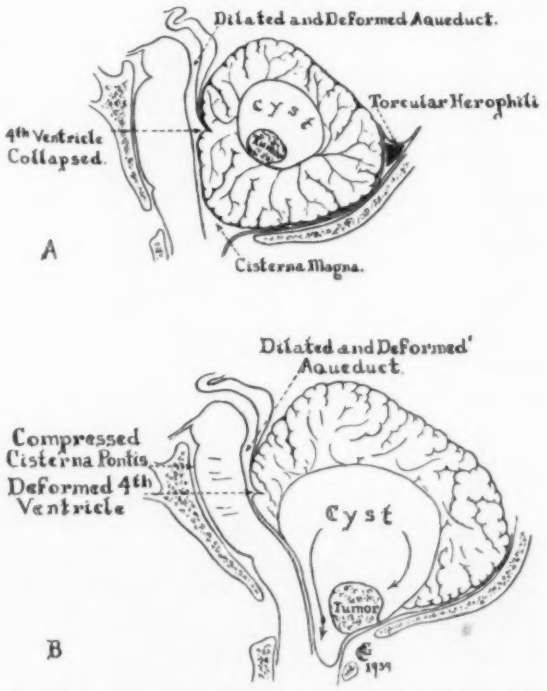

FIG. 8. Schematic representation of cystic hemangioblastoma of the cerebellum, showing dilatation and rostral bending of the aqueduct of Sylvius, narrowing of the cisterna pontis and compression of the fourth ventricle. *A*, early stage in development of the tumor; *B*, late stage.

in which a positive diagnosis of hemangioblastoma of the cerebellum was made from the roentgenograms but in which the tumor was inaccessible at a primary operation, deliberately to leave the patient with only a suboccipital decompression and to return at some later date to find the tumor within the operative field and readily amenable to surgical removal.

We are aware that Lindau, in his monograph, stated that the "topography of these tumors is characteristic. They appear both on the dorsal and ventral surfaces of the cerebellum but show especially a localization partly posteriorly and partly laterally. In the midline and forward (superior vermis), they are practically never seen. The part of the cerebellum in which they are most common is the tonsil." One must keep in mind, however, that Lindau's material was obtained at necropsy and even those patients who died as a result of operation were operated upon relatively late. In contrast to this, the authors' series of cases, on the whole, were encountered earlier in the development of the tumor, which was localized frequently only by the aid of pneumo-encephalography.

In a review of the 11 cases of cerebellar hemangioblastoma included in the monograph of Cushing and Bailey, there also occurred 3 tumors which were not seen at a primary operation and were readily disclosed at subsequent procedures. This again suggests that many tumors of this type may be located originally in the superior and anterior portions of the cerebellum and migrate caudally in the direction of the bony decompression. In a fourth case in Cushing and Bailey's series, the tumor was seen high up under the tentorium at the first operation. At a second exposure, five months later, while still adherent to the tentorium, it had extended as a result of growth downward almost to the foramen magnum. In this case the tumor was a solid one. In the presence of a cyst, such a downward extension may take place even more readily.

Thus in a total of 24 cases (Cushing and Bailey—11 cases and 13 in our series), 8 cases (33.3 per cent) occurred in which evidence was available that the tumor migrated from a superior, anterior and deep position within the cerebellum to an inferior, posterior and superficial one. It is therefore logical to suppose that in many of the remaining 16 cases also, the tumor originated in the superior, anterior and deep portions of the cerebellum but was found in the inferior, posterior and superficial sites only because the tumor, or cyst plus tumor, was encountered in these cases in a later stage of development. That this is not true in all the cases of hemangioblastoma of the cerebllum is indicated by one of our cases in which the fourth ventricle was markedly dilated and displaced upwards in the ventriculogram by an inferiorly placed tumor.

Furthermore, these changes may occasionally be seen in other types of cerebellar tumors. Thus, although characteristic, they are not pathognomonic of hemangioblastomas.

SUMMARY AND CONCLUSIONS

The cardinal features for the diagnosis of hemangioblastoma of the cerebellum are described. These are: a middle aged patient with the pneumo-encephalographic findings of slight to moderate dilatation of the lateral and third ventricles, moderate enlargement of the aqueduct of Sylvius, rostral bending of the caudal half of the aqueduct of Sylvius and narrowing of the cisterna pontis. An explanation for these distinctive pneumo-encephalographic changes, based on the relation of the tumor to the cerebellum and to the cerebral fluid cavities, is presented. The plain roentgenograms usually reveal only slight atrophy of the posterior clinoid processes, floor and dorsum of the sella turcica.

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A DISCUSSION OF ROENTGEN PELVIMETRY AND THE DESCRIPTION OF A ROENTGEN PELVIMETER*†

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FOR nearly a score of years I have been interested in adapting roentgen techniques to clinical problems in obstetrics. From almost the beginning of these studies so impressive has been the information obtained regarding pelvic architecture that the use of roentgen pelvimetry as a routine procedure in primigravid women has been urged. During the past six years in our clinic such practice has been followed and the results from all points of view have amply justified the procedure. It is therefore with considerable interest that we note a recent statement of a noted leader of obstetrical thought, J. M. Munro Kerr,[1] who writes, "I do not think that, with the knowledge now at hand regarding the influence excited by even minor variations of pelvic formation, we who advocate routine pelvic radiography for all primigravidae have lost our sense of proportion in this matter, as many suggest today. On the contrary, I make bold to predict that before many years pass it will be accepted as an essential detail of the antenatal examination."

For many years obstetricians placed reliance upon external pelvimetric methods to furnish an index to pelvic capacity. Modern roentgen studies have definitely shown that these may not be relied upon and at best can give but a general idea of pelvic room. It seems clear that if pelvimetry is to be at all useful in determining pelvic capacity, accurate measurements of the bony pelvis must be made. These can be obtained only by roentgen methods. In this connection the attitude of Dippel[2] is worth repeating. "It may be argued," he writes, "that there are so many factors in labor, namely, the size of the baby and the character of the uterine contractions, that an approximation is enough. We do not agree with this viewpoint. The very fact that these other factors are difficult to evaluate accurately makes it all the more important, in cases of contracted pelvis, that we should have as precise information as possible concerning the one factor that we can measure with precision."

It has been suggested by some that the use of roentgen pelvimetry should be reserved for cases of suspected disproportion or of arrested labor. In the light of present knowledge concerning pelvic variations and abnormalities, such an attitude is thoroughly unscientific. It has also been stated that because of the expense involved, only well endowed and specially equipped hospitals can avail themselves of such modern aids to obstetric procedure. Such is by no means the case. The use of standard roentgen equipment with one or two inexpensive accessories and the exposure of two 10″ ×12″ films is all that is necessary for an adequate routine pelvimetric survey. The expense and labor charges under these conditions will approach a minimum that compares favorably with such laboratory procedures as the blood count or the urinalysis.

Let us consider the particular information which will offer the obstetrician useful knowledge of pelvic capacity. Such information will be furnished by the measurement of certain pelvic diameters and the description of certain contours. There are three portions of the pelvis which are obstetrically important:

1. The plane of the pelvic inlet
2. The midpelvic plane
3. The planes of the outlet.

Certain diameters of these planes will furnish a concept of the architecture of the

* This investigation was aided by grants from the Fluid Research and Teaching Funds of Yale University School of Medicine.
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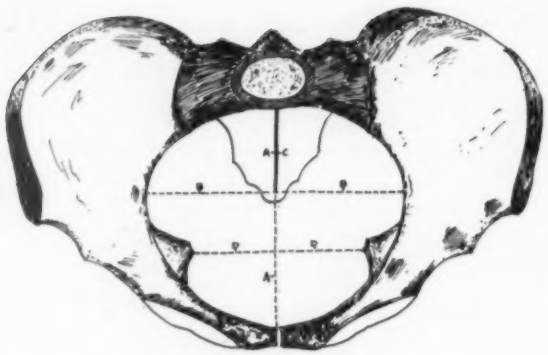

Fig. 1. The plane of the pelvic inlet. *A*, anteroposterior diameter; *B*, transverse diameter; *C*, posterior sagittal diameter; *D*, transverse of midplane, see text.

pelvis and its capacity. In addition, a knowledge of certain contours is also essential and these contours are:

1. The shape of the pelvic inlet
2. The shape of the subpubic arch
3. The shape of the sacrosciatic notch
4. The shape of the anterior surface of the sacrum.

The essential diameters of the plane of the pelvic inlet are (Fig. 1):

1. Anteroposterior. This extends from a point on the posterior surface of the symphysis 1 cm. below its superior border posteriorly to that part of the upper sacrum where the iliopectineal lines would meet if extended. (This posterior point may or may not be located at the sacral promontory.)
2. Transverse. The widest distance separating the iliopectineal lines.
3. Posterior Sagittal. That part of the anteroposterior diameter which lies posterior to its intersection by the transverse diameter.

The essential diameters of the midplane are (Figs. 1 and 2):

1. Anteroposterior. From a point on the lower posterior border of the symphysis extending posteriorly at the level of the ischial spines to the sacrum at a point usually between the fourth and fifth sacral vertebrae.
2. Transverse. The narrowest distance separating the ischial spines (also called the bispinous diameter).
3. Posterior Sagittal. That part of the anteroposterior diameter which lies posterior to its intersection by the transverse.

The essential diameters of the outlet are (Figs. 2 and 3):

1. Transverse. The distance between the lower inner surfaces of the tubera ischii. (Also called the bituberal diameter and readily measured by manual palpation and therefore not of necessity measured roentgenologically.)
2. Posterior Sagittal. The distance between the midpoint on the transverse diameter and the tip of the sacrum.

The importance of these posterior sagittal diameters is that they furnish excellent indices of the important posterior room in the pelvic planes described. Relative shortening of any or all of these diameters may have considerable obstetric significance.

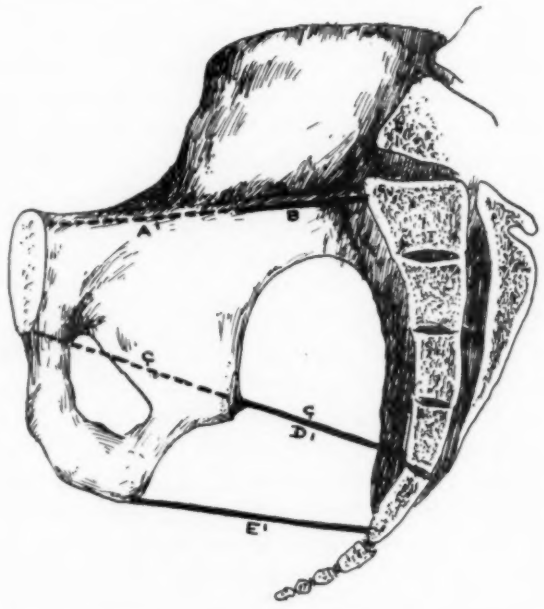

Fig. 2. Anteroposterior pelvic diameters seen in lateral aspect. *A*, anteroposterior diameter of inlet; *B*, posterior sagittal diameter of inlet; *C*, anteroposterior diameter of midplane; *D*, posterior sagittal diameter of midplane; *E*, posterior sagittal diameter of outlet.

In evaluating these cardinal pelvic diameters the obstetrician should be familiar with the newer knowledge of the variations that occur in female pelves and also with the sex characteristics of both female and male pelves.

Of importance also is the evaluation of the pelvic contours previously referred to. These are:

1. The shape of the pelvic inlet. It should be noted whether the inlet is symmetrical or asymmetrical. The convergence of the iliopectineal lines forming the anterior segment of the inlet should be also noted as to whether this portion is wide, average, or narrow.
2. The shape of the subpubic arch. This is readily determined by palpation with the inner surface of the thumbs of the examiner, and the terms arcuate or straight are used.
3. In the lateral pelvic roentgenogram the shape of the sacrosciatic notch is of significance. This may be wide, average, or narrow in either the upper or lower portion, dependent upon the relative position of the sacrum. The characteristic type, male or female, should be noted.
4. In the lateral pelvic roentgenogram the vertical contour of the anterior sacral surface should be noted. By vaginal and rectal palpation these sacral contours may also be evaluated.

The accompanying *pelvic estimation chart* (Fig. 4) for the recording of such data is

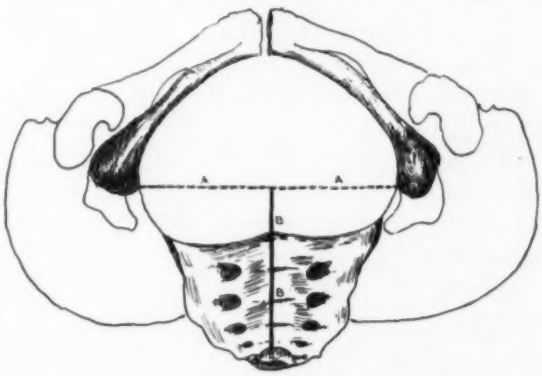

Fig. 3. The important outlet diameters seen from below. *A*, transverse diameter; *B*, posterior sagittal diameter.

New Haven Hospital and Dispensary—Pelvic Estimation Chart

Name _____ Date _____ No. _____

External Measurements
Spines ____ cm. Crests ____ cm. Ext. Conj. ____ cm.
Pubic Arch Wide Average Narrow
Rami Arcuate Straight
Bituberal ____ cm. Post Sag. ____ cm.

Rectal and Vaginal Examinations
Ischial Spines Large Average Small
Side Walls Parallel Convergent
Sacrum A. P. Curve Concave Straight Convex
Lat. Curve Concave Straight Convex
Notch Wide Average Narrow
Coccyx Movable Immovable
Straight Projects anteriorly
Diag. Conj. ____ cm. Not reached
Conclusions _____
_____ Examiner

Roentgen Measurements
INLET MIDPLANE OUTLET
A. P. ____ cm. A. P. ____ cm. Bituberal ____ cm.
Trans. ____ cm. Trans. ____ cm. P. S. ____ cm.
P. S. ____ cm. P. S. ____ cm.

Pelvic Contours
Inlet Symmetrical Asymmetrical
Ant. Segment Wide Average Narrow
Notch Wide Average Narrow

Type of Pelvis _____

Comment _____
_____ Examiner

Fig. 4

that which is in use in our clinic. This record is filed with the prenatal record and is therefore available whenever the patient may enter the hospital for delivery. We use a simple classification for pelves which is based upon the general shape of the pelvic inlet. It is entirely arbitrary but it does seem to have definite practical value. The intermingling of sex characters and the variability of pelvic form is so great that other classifications which are based upon these factors are bound to be confusing.

In general we consider that the shape of the pelvic inlet may assume one of four forms (see diagram) (Fig. 5):

1. An anteroposterior oval
2. A circle
3. A transverse oval
4. An exaggerated transverse oval.

To be more specific and for purposes of record we further describe the morphology for these four types as follows:

1. Dolichopellic or anthropoid type pelvis. The transverse diameter is less than the anteroposterior.

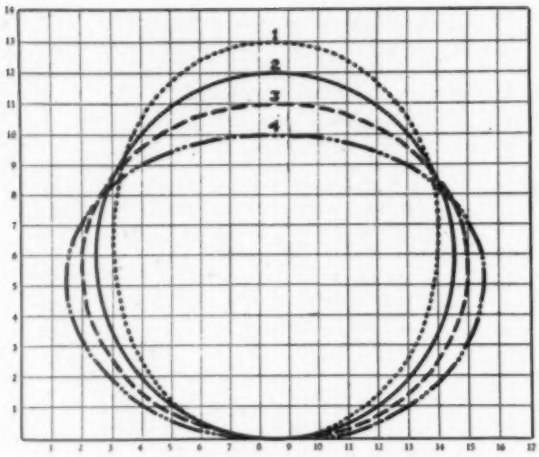

Fig. 5. Diagram showing usual pelvic variations in four groups, see text.

2. Mesatipellic or round type pelvis.
   The transverse diameter is equal to, or slightly (not more than 1 cm.) more than, the anteroposterior.
3. Brachypellic or oval type pelvis.
   The transverse diameter is more than 1 cm. and less than 3 cm. greater than the anteroposterior diameter.
4. Platypellic or flat type pelvis.
   The transverse diameter is 3 cm. or more than the anteroposterior diameter.

This classification, it should be emphasized, is useful simply as a basis for the description of pelves and is, of course, supplemented by the information gained from the diameters and contours of other portions of the pelvis.

The grid method for anteroposterior views and the lateral projection with the upright centimeter rod are procedures for roentgen pelvic mensuration which have been developed in this clinic and which have been described from time to time by myself and others.[3] The grid method consists essentially in projecting the pelvic inlet after it is made parallel to the film and correcting the spread of the rays by means of projecting on the same film a centimeter grid with a second exposure. Diameters of the pelvic inlet thus may be read directly on the film. The bispinous diameter may also be read on this film by using a correction table for the level at which they rest.

The lateral exposure consists of projecting the lateral aspect of the pelvis with the patient in a standing lateral position. Distortion is measured by means of an upright centimeter notched rod placed in the sagittal body plane in the fold of the buttocks. By means of these "projected" centimeters correction is made for the midplane of the body and all anteroposterior diameters of the pelvis may be measured. In the anteroposterior grid technique the target-film distance is 30 in. and in the lateral view 40 in.

In the present communication these appliances are eliminated and a plea is made for the use of a standard target-film distance for both views for two reasons:

1. Using a standard target-film distance a distortion table or a correction instrument, such as herein described, will make the correction of the spread factor one of great simplicity.
2. The use of standard target-film distance will give relative standard size projections and abnormalities in both size and shape may be readily appreciated.

The present communication proposes, therefore, to discuss this simplification of roentgen technique. The procedure, it will be seen, is essentially that used in the techniques referred to above with the exception that the grid and upright centimeter rod are not used for correction of spread and the calibrated calipers is substituted. These calipers (Fig. 6) are corrected for various horizontal distances above the film using a standard target-film distance of 36 in. This procedure is in reality an adaptation of a technique which I described in 1925,[4] and the corrections are made in the same manner as was then delineated. It is obvious, if we know the distance above the film of the horizontal plane which we wish to measure and if a standard target-film distance is maintained, that such a procedure may be relied upon for accuracy. This is particularly the case if the reading scale is a relatively large one

and one on which corrected centimeter distances are great enough so that quarter centimeters (0.25 cm.) may be easily read. The reader hardly needs to be reminded that pelvic measurements which are accurate to this figure are entirely adequate for obstetrical purposes.

The technique is essentially as follows:

For routine purposes we insist upon two views, one of the pelvic inlet and one lateral projection. Both views are necessary for the mensuration of the diameters described above. Furthermore, each view becomes an excellent check upon the other as the inlet anteroposterior diameter may be measured in both. The technique for the lateral projection follows:

1. The patient removes her clothing, changing to heelless slippers and the usual hospital bedgown open at the back (Fig. 7).

2. She is placed in front of an erect Potter-Bucky diaphragm with either lateral aspect of the body toward the target. A 36 in. distance is used. The arms are folded across the chest.

Fig. 7

Fig. 6. Measuring calipers calibrated for 36 in. distance. Photograph reduction to one-half size.

3. The target is centered on a point on the external conjugate diameter about one-third the distance from the symphysis pubis to the depression under the fifth lumbar vertebra.

4. A binder is placed around the patient and attached to the cassette changer to insure steadiness during the exposure, which varies with the thickness of the patient, all other factors being constant.

5. Before the exposure is made the distance from the midplane of the body to the film is measured in centimeters and this distance is recorded by a marker on the film.

Comment on Lateral Technique

When developed and viewed the following landmarks should be identified: anterior and posterior borders of symphysis pubis, ischial spines, ischial tuberosities, promontory and anterior surface of sacrum, and the sacrosciatic notch. On one edge of the film will be seen the marker noting the dis-

Fig. 8. Lateral roentgenogram (see Fig. 2). Diameters shown as in Figure 2.

tance of the body midplane from the film at the time of exposure. Using this calibration on the calipers the anteroposterior diameters of the pelvis may be read directly.

(Note.) Although we recommend the upright posture for lateral films, it is obvious that if the patient is in active labor the standing position may be impractical. In such instance lateral films in the lateral horizontal position are made using the same technique.

The following pelvic diameters are measured in the lateral view (Fig. 8):

1. Anteroposterior diameter of inlet.
2. Anteroposterior diameter of midplane.
3. Posterior sagittal diameter of midplane. If two shadows of the ischial spines are seen, the anterior endpoint of this diameter is chosen as the middistance between these shadows.
4. Posterior sagittal diameter of outlet. The anterior endpoint of this diameter is chosen on the lower edge of the tuber ischii posteriorly near the point where the upward curvature begins. If two shadows are seen the middistance between these points is chosen. The posterior endpoint is the tip of the sacrum as described above.

In addition to these diameters certain lateral contours are of importance. The shape of the anterior surface of the sacrum and the character of the sweep of the sacrum from above downward should be noted. The shape of the sacrosciatic notch —wide, average, narrow, male or female type—should be ascertained. If fetal parts are seen, their relation to the birth canal should be noted.

TECHNIQUE FOR INLET PELVIMETRY

In placing the patient in position for inlet pelvimetry we endeavor to make the pelvic inlet horizontal. For this purpose a back rest is necessary as shown in Figure 9. Two points on the body must be measured in centimeters above the film. Calipers and a centimeter scale are used allowing for the distance between the table top and the film.

1. A point on the anterior surface of the symphysis 1 cm. below the superior border.
2. A point on the patient's back in the interspace between the fourth and fifth lumbar vertebrae (Fig. 9).

(Note.) For practical purposes an imaginary line drawn between these two points will bisect the plane of the pelvic inlet (Fig. 10). In case these readings are slightly different owing to a slight tilt in the pelvis,

Fig. 9

the mean distance is taken. However, there is no reason why by slight adjustment of the patient's position similar readings for both endpoints are not obtainable. The question might be raised as to whether such an imaginary line will traverse the pelvic inlet in all pelves. From observations on numerous dried pelves and from many checks by the lateral technique, I am quite convinced that for obstetric pelvimetric purposes this concept is correct.

3. After having made the pelvic inlet horizontal the target is centered in the midline about 6 cm. posterior to the upper border of the symphysis. The centimeter distance marker is placed over the film and the exposure made.

On developing and viewing the film (Fig. 11) the outline of the pelvic inlet is seen and shadows of the ischial spines. For measuring the anteroposterior, transverse and posterior sagittal of the inlet the calipers are used employing the calibration for the level of the pelvic inlet above the film as previously determined and shown by the marker. Before measuring the interspinous distance the level of these eminences must be determined in the lateral film. This level is determined by measuring downward from the level of the pelvic inlet. Thus, if the pelvic inlet was 18 cm. above the film in the inlet view, and the lateral view shows

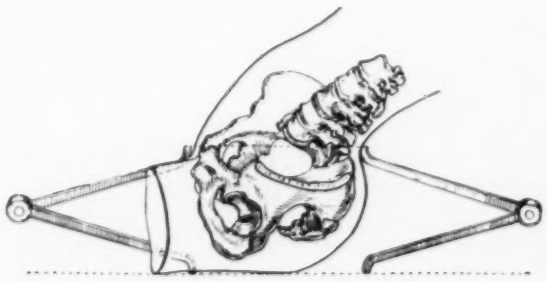

Fig. 10

the spines to rest 6 cm. below this, the spines rested in the 12 cm. level at the time of taking the inlet view. Therefore, one must use the 12 cm. calibration for measuring the interspinous distance.

Fig. 11. Roentgenogram of pelvic inlet (see Fig. 1). Diameters shown as in Figure 1.

Four diameters are measured in the inlet view:

1. Anteroposterior diameter
2. Transverse diameter
3. Posterior sagittal diameter
4. Interspinous diameter.

The contours which are of importance are:

1. Symmetry or asymmetry of the pelvic inlet
2. The shape of the anterior segment—narrow, average, or wide.

In concluding, I would observe that until the time arrives when, by means as yet undiscovered, roentgen rays may be made parallel, the distortion of images due to spread must be corrected for purposes of mensuration. For pelvimetry it is difficult to conceive of techniques which are simpler than those herein described. The information which thus becomes available to the obstetrician will furnish him an adequate knowledge of bony pelvis and its capacity. Beyond this pelvimetry alone cannot furnish information. It should be clear that to offer definite obstetrical prognosis from pelvimetric films alone is an unwarranted

and possibly dangerous procedure. Many factors other than pelvic capacity are concerned in successful parturition. Obviously, the reading of films by both the obstetrician and the roentgenologist is essential for proper interpretation. In cases of suspected disproportion at term, cephalopelvic relationships as revealed by lateral films are of great value; however, as the present paper concerns itself solely with pelvimetry, the discussion of such studies is not within its province.

Routine roentgen pelvimetry for primigravid women should be no longer a Utopian dream, and it is certain that by its employment better obstetric care during labor will result. Obstetricians will agree that, while it is often possible to drag forcibly a live baby through a somewhat restricted pelvis, it is not often good obstetrics to do so no matter how skillfully performed. Modern obstetrics demands that, in the interest of both mother and child, labor must be conducted with a minimum trauma to both and a forehand knowledge of bony pelvic capacity as revealed by roentgen pelvimetry will aid considerably in the accomplishment of this desideratum.

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Vol. 44, No. 1

POLYOSTOTIC FIBROUS DYSPLASIA

REPORT OF A CASE WITH UNILATERAL INVOLVEMENT*

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RECENTLY Horwitz and Cantarow[1] reported a case of polyostotic fibrous dysplasia. They stated that this skeletal disease had been described in the literature under a variety of designations, including osteodystrophia fibrosa unilateralis, osteitis fibrosa localisata, osteodystrophia fibrosa generalisata, fibrous osteodystrophy and osteitis fibrosa disseminata. They also called attention to the necessity of excluding hyperparathyroidism since the osseous changes simulate roentgenographically those due to this disease. Credit for the term "polyostotic fibrous dysplasia" was given to Lichtenstein and Jaffe.

Horwitz and Cantarow felt that the possible presence of this disorder is frequently overlooked in cases in which the roentgenographic picture of osteitis fibrosa cystica generalisata is present without definite evidence of hyperparathyroidism. Cherry[2] recently reported a case of osteitis fibrosa of the mandible and multiple lesions of the skull. The blood calcium, phosphorus and phosphatase values of the blood were normal. The patient was a male, aged twenty-six, whose illness began at the age of thirteen. No explanation was given as to the etiology. New, in his discussion of the case, said that osteitis deformans and osteitis fibrosa are apparently expressions of the same disease.

We are reporting a case similar to that of Horwitz and Cantarow. Our case had, in addition, an involvement of the skull.

CASE REPORT

E. C., aged sixteen, was admitted to Harper Hospital on August 18, 1939, with the complaint that a soft mass had been developing rapidly in the right occipital region.

Past History. On August 6, 1935, the patient was admitted to the Children's Hospital of Michigan with a history of fatigability and limping because of pain in the right leg. Duration of symptoms was six months. A firm tumescence in the right parieto-occipital region had been noted for one year. The roentgenologist, Dr. E. R. Witwer, reported "a variation in texture and density of the right ilium, right femur and right tibia and fibula suggestive of an osteitis fibrosa cystica, although no frank cystic areas are made out." Roentgenograms of the skull "demonstrate distinct thickening of the outer table of the skull with unusual rarefaction and some loss of normal trabecular detail. The inner table of the skull appears to be intact."

The laboratory studies made at that time were as follows:

Serum calcium, 10.4 mg. per 100 cc.; phosphorus, 3.2 mg.; creatinine, 1.6 mg.; cholesterol, 109.6 mg.; total serum protein, 7.31 per cent; albumin, 4.02 per cent; globulin, 3.29 per cent; phosphatase, 8.4 Bodansky units; blood Kahn reaction negative; erythrocytes, 4,980,000; hemoglobin, 88 per cent (Sahli); leukocytes, 10,500; differential leukocyte count: polymorphonuclear neutrophiles, 72 per cent; lymphocytes, 28 per cent; morphology was normal; uric acid, 3.45 mg. Urinary findings were normal.

Roentgenograms of the chest were reported as normal.

Orthopedic examination revealed normal upper extremities. Measurement of the lower extremities was as follows:

Length—Lower right leg, 69.22 cm. Left leg, 66.04 cm.
Circumference—Right thigh, 30.48 cm. Left thigh, 34.29 cm.
Circumference—Right calf, 22.86 cm. Left calf, 22.86 cm.

He was discharged on August 14, 1935, and was re-admitted to Children's Hospital on January 15, 1936, with a fracture through the cystic area of the right femoral shaft and through the cystic area of the right lower third of both tibia and fibula. He was placed in a cast and discharged one week later. He made

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FIG. 1. Large cyst of skull.

an uneventful recovery and was followed in the outpatient department.

He was again admitted to Children's Hospital on March 30, 1936. Four days later Dr. Charles Peabody explored the right femur and obtained biopsy material, which was reported as showing "great increase in fibrous connective tissue between the trabeculae of bone. No giant cells are seen, and there is no evidence of tuberculosis. No active marrow is seen in some of the sections, while in others there is a small amount of marrow between the trabeculae. There are a few blood vessels in the connective tissue and no mitotic figures are seen." He was discharged April 7, 1936.

In June, a roentgenogram showed that the fractures of the upper right femur were healed and the cystic areas had filled in to some extent.

Family History. This is of importance and will be referred to later. The parents were of Polish extraction, but born in the United States. The father was thirty-nine years old, 172.72 cm. (68 inches) in height and weighed 76.7 kg. (169 pounds). The mother was thirty-four years old, 154.94 cm. (61 inches) in height and weighed 65.8 kg. (145 pounds). The maternal grandmother was 149.86 cm. (59 inches) in height, and the maternal grandfather was 157.48 cm. (62 inches) in height. Two maternal aunts were 152.40 cm. in height.

The patient's mother had all upper teeth removed at the age of thirty and, when seen October 14, 1939, the lower teeth were decayed. The maternal grandmother had all teeth removed at the age of twenty-seven. Two of the patient's maternal aunts had poor teeth—one had false teeth at the age of twenty-eight and the other at the age of twenty-four.

During a period of four years this patient was admitted to Children's Hospital several times and biopsy material was obtained from the cyst of the right tibia. The pathological report was the same as the previous report. He was followed at the Children's Hospital regularly until August 18, 1939, when he was admitted to Harper Hospital. At this time he complained of a non-tender swelling in the right occipital region. This had been present for five weeks.

On examination in August, 1939, there was found a soft mass in the right parieto-occipital region. Its diameter was about 10 cm. (4 inches) (Fig. 1). It fluctuated on pressure. He had a high arched palate and the teeth were in good condition. Fundus examination was negative. There was no suggestion of a beard and there was absence of axillary hair. His voice was of of the puerile type. The breasts were distinctly feminine (Fig. 2). The thyroid gland was not enlarged. There was a feminine distribution of pubic hair. Operative scars were present on the

FIG. 2. Feminine type of breast.

right outer thigh, right knee, and right malleolar area. There were no abnormal neurological findings.

Roentgen study was made of the skull in the standard positions. The film exposed in the anteroposterior direction (Fig. 3) reveals rather marked hypertrophy of both the inner and the outer table of the skull, but the changes involve particularly the outer table of the skull in the occipitoparietal area, extending as far forward as the wing of the sphenoid. In addition to this hypertrophy, which has involved principally the outer table, there are cystic changes involving both the inner and the outer table of the skull, with some erosion of the inner table of the skull in the occipital region, with considerable pressure erosion involving the inner table of the skull in the occipitoparietal region.

The study of the pelvis (Fig. 4) reveals cystic changes involving the intertrochanteric region and the neck of the right femur with some expansion and thinning of the cortex particularly over the mesial aspect of the femoral neck. The capital femoral epiphysis of the right femur is uninvolved in the process, the changes ending abruptly at the epiphyseal line, involving all the diaphyses—changes similar to those seen in the intertrochanteric region and neck of the femur, extending down the entire shaft of the femur (right).

Fig. 3. Roentgenogram of skull. Right-sided cyst formation.

Fig. 4. Cyst formation of right femur.

The roentgen study made of both legs in the anteroposterior plane reveals a normal appearance of the bone structure of the left leg. The right leg reveals marked hypertrophy of both the tibial and fibular shafts with thinning of the cortex and elongation of the shafts of the bones incident to the hypertrophy as compared with the normal left leg. The medullary portion of the tibial shaft of the right leg reveals a ground-glass appearance. As was noted in the femur, the disease process stops abruptly at the epiphyseal line, neither the tibial nor fibular epiphyses being involved in the process (Fig 5).

Conclusion. The roentgen study of the skeleton reveals the bone changes involving the right occipitoparietal region of the skull, the right femur, particularly the intertrochanteric region and the neck of the right femur, and the right tibia and fibula.

The exact nature of the process which has involved the right half of the skeleton is not determined from the roentgen study.

Laboratory studies were reported as follows:

	Serum calcium per 100 cc.	Serum phosphorus per 100 cc.
August 18,	7.9 mg.	4.2 mg.
August 19,	8.1 mg.	3.6 mg.
August 24,	10.5 mg.	3.5 mg.
Phosphatase—Bodansky units		
August 18,	19.1	
August 24,	18.1	

Fig. 5. Hypertrophy of right tibia and fibula resulting in lengthening of leg.

Blood cholesterol, 120.5 mg. Kahn negative on three examinations.

Red blood cells, 4,030,000; hemoglobin, 89 per cent (Sahli); leukocytes, 15,700; segmented, 68 per cent; stab forms, 8 per cent; lymphocytes, 20 per cent; mast cells, 2 per cent; eosinophiles, 2 per cent; morphology normal.

Dextrose tolerance test

Fasting blood sugar, 104 mg. per 100 cc.

¾ hour,	156 mg.
1½ hours,	126 mg.
2½ hours,	130 mg.

No glycosuria was present during the test.
The basal metabolic rate was minus 16 per cent.

On August 21, 1939, an incision was made encircling the tumor mass of the skull and a blue dome cyst was exposed (Schreiber) (Fig. 6). The cyst had a purplish blue color as if it contained blood or dark fluid. On incising the cyst wall it was seen to be filled with xanthochromic fluid and there was bleeding from some of the daughter cysts which were attached to the wall of the cyst. The dura was exposed in the upper parietal part of the exposure and appeared fairly normal. On sucking away the small blood-filled cysts, which varied in size from that of a pea to a grape, it was seen that they were densely attached to the dura in the lower parietal region (Figs. 7 and 8).

An attempt was made to encircle the cyst with trephine openings in the hope of removing the bone and cyst in toto. However, the bone proved to be of cheesy material and markedly thickened in the anterior portion, at some places being 1½ inches in thickness, and it was impossible to separate the bone from the dura. Consequently, the excess bone tissue about the margin of the exposure was rongeured away and as much of the cystic material as possible sucked away. The wall of the cyst was separated with the endothermy. In all the cyst contained about 5 ounces of fluid.

Dr. P. F. Morse's pathological report read as follows: "The examination of the specimens removed at biopsy shows fragments of partially calcified bone and osteoid tissue. The more superficial areas have the appearance of periosteum. This periosteum-like tissue is edematous and there are areas of diffuse round cell infiltration around the vessels, giving the appearance of a low grade inflammatory reaction (Fig. 9). There are also areas of young connective tissue undergoing hyaline transformation and containing large dilated blood spaces (Fig. 10). These resemble some areas found in callus formation. Besides this, there are osteoid areas in which hyaline bone trabeculae, either with no calcification or with small calcified particles, appear in the form of osteoid tissue of uniform structure. The marrow spaces of this osteoid tissue are fibrosed and the picture resembles that of osteitis fibrosa except that there is no osteoclastic reaction. The osteoclastic giant cells are absent, and the characteristic areas of localized hypertrophy and the piling up of osteoblasts are not seen in this tissue (Fig. 11). Other areas are apparently those of fairly normal bone around the margin of the lesion. There is nothing remarkable in this portion of the specimen" (Fig. 12).*

* Our thanks are due to Mr. Frank N. Ruslander, medical photographer of Harper Hospital, for the excellence of the photographs.

FIG. 6. "Blue dome" cyst before opening

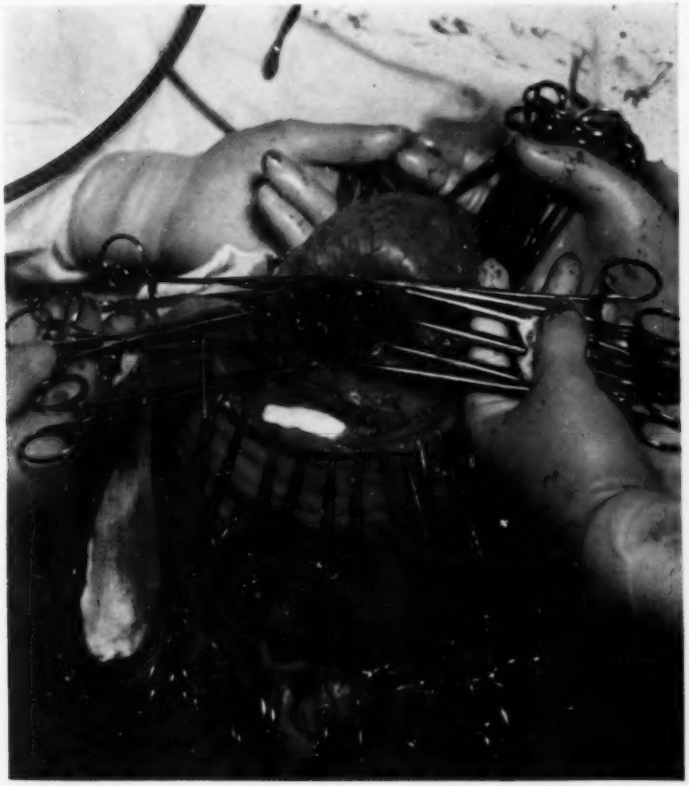

FIG. 7. Interior of large cyst, showing smaller cysts studding the wall.

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Fig. 8. Section of large cyst wall showing small individual cysts.

The patient made an uneventful recovery and was discharged September 1, 1939. There was no sign of recurrence when examined ten months after operation.

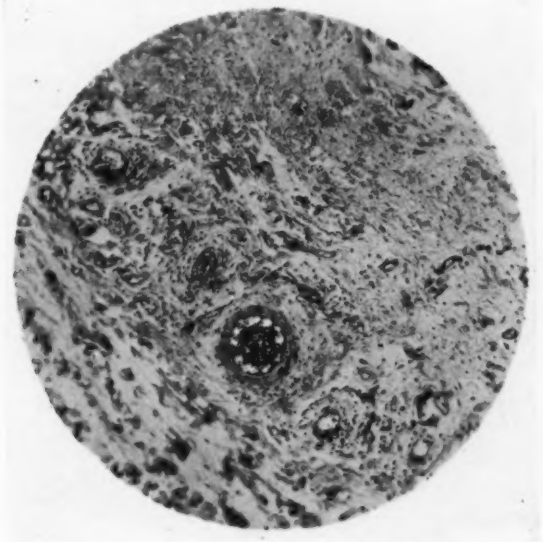

Fig. 9. Periosteal area with edema and round cell infiltration. Magnification ×100.

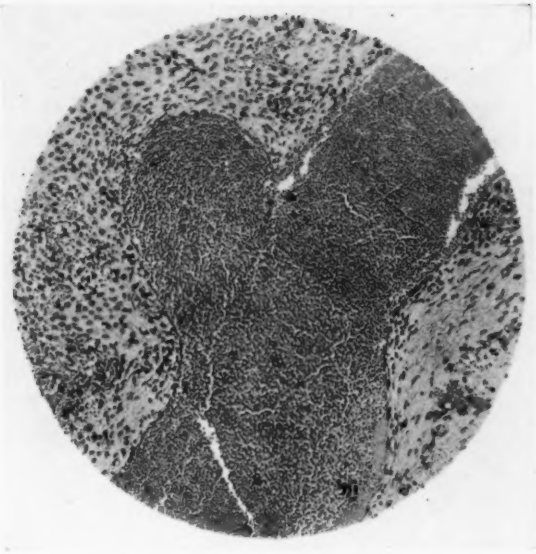

Fig. 10. Fibrous area with large blood space. Magnification ×100.

COMMENT

This patient showed the characteristics of polyostotic fibrous dysplasia unilateralis. The cystic condition was confined to the right side of the skeleton. That hyperparathyroidism was not the cause of the condition is evidenced by the normal values for serum calcium and phosphorus, as well as the fact that the condition involved four

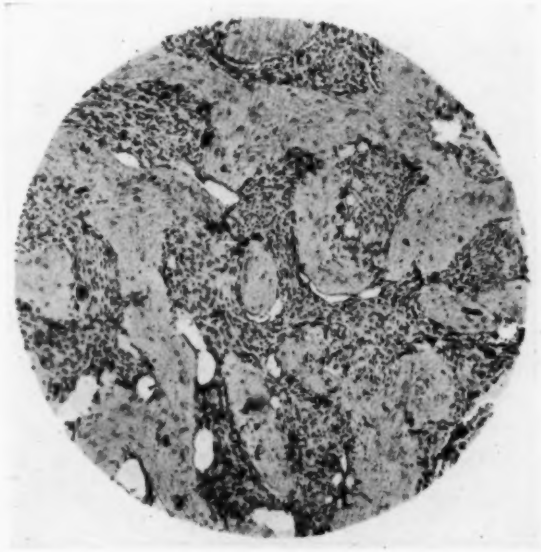

Fig. 11. Osteoid tissue with uncalcified bone trabeculae and fibrosis of marrow. Magnification ×100.

different localities on the same side of the body, certainly a most unusual coincidence if hyperparathyroidism were present.

Horwitz and Cantarow stated that the changes in the bones "apparently result from perverted development of the bone-forming mesenchyme, and a congenital

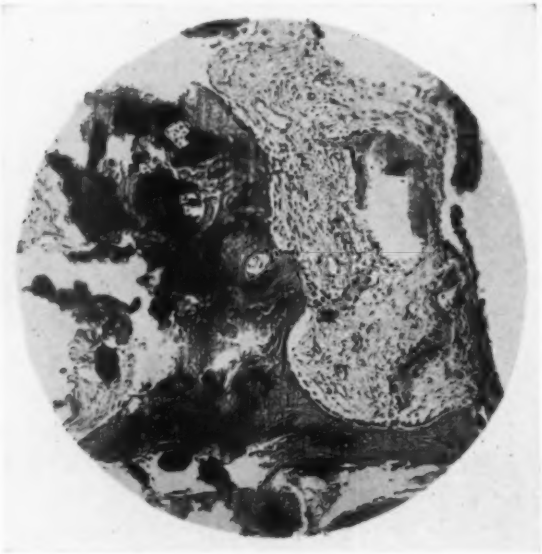

Fig. 12. Bone fragment from margin of lesion. Magnification ×100.

basis has been suggested." The possibility exists that there is an autochthonous peculiarity of the mesenchymal bone, but this still leaves us in the dark.

There are three features in this case which, in our opinion, shed light on the etiology and help to explain the unilateral involvement.

First, it will be noted that the patient's mother, maternal grandmother and two maternal aunts had false teeth at a very early age, namely, at thirty, twenty-seven, twenty-eight and twenty-four years, respectively. This is presumptive evidence that there was defective development in the bony mesenchyme (the dentin and cementin) of the teeth on the maternal side.

Second, the heights of the mother(154.94 cm.), the maternal grandmother (149.86 cm.) and the maternal grandfather (157.48 cm.), were definitely shorter than the average sampling of the general population. The shortening of the skeleton seemingly was a dominant maternal characteristic.

Morgan[3] said, "There is evidence from several sources showing that human stature is largely due to inherited factors. There are probably several, or many, different kinds of genetic factors that affect the height of man. These have become mixed in so many ways in our present population that it is difficult to disentangle them. Not only may some of these factors influence different parts of the body differently, such as length of legs or back or neck, but in addition there are probably also factors that determine the size and quality of the glands of internal secretion, which in turn affect materially both the rate of growth and the time of cessation of growth."

Third, the patient showed certain feminine characteristics: feminine type of breasts, feminine distribution of pubic hair, no beard, no axillary hair and a puerile voice. These characteristics are usually associated with hypopituitarism.

We may, on the basis of the foregoing, postulate the etiology as follows: From the mother, the patient inherited a defect of the mesenchymal bone and a normal bony skeleton from the father. In order to understand the unilateral bone defects on the right side, we could assume an unbalanced chromosomal aberration. As Mohr[4] said, "Every now and then it happens in insects, birds and other forms that individuals occur which are *sex mosaics*, female on one side, male on the other, so-called gynandromorphs." He goes on to say that somatic chromosome mutations may possibly offer an explanation of some of the cases of congenital unilateral character changes in man, such as are seen in congenital hemihypertrophy.

What determines that there should be a maldevelopment of the osseous system? The close relationship existing between the pituitary gland and bone development is well known. Attention is called to the fact that the patient had a high arched palate

and elsewhere one of us (Moehlig[5]) has reported the association of a high arched palate with pituitary disturbances, since the anterior pituitary develops from the roof of the mouth. A defect in the development of the hard palate not infrequently involves the pituitary gland with resulting dyspituitarism.

Mortimer[6] has shown that cranial dysplasia in an individual is produced by dyspituitarism and not by autochthonous peculiarity of certain tissues in response to a normal secretion from the anterior pituitary. He said, "That the cranial deformity resulted in response to abnormal pituitary function is reasonable, the presumption being that those in whom a dyspituitarism is physiologically recognizable today, and in whom a cranial dysplasia also exists, suffered also from a dyspituitarism at the time when cranial form and structure are most susceptible to hormonal growth influences." Mortimer believes that in cases where a familial tendency to such deformity undoubtedly exists, a familial tendency to dyspituitarism may be suspected.

In the case of our patient, a familial dyspituitarism was no doubt present on the maternal side. This is evidenced by the shortness in stature of the mother, maternal grandfather and maternal grandmother, as well as two maternal aunts. Furthermore, in these same individuals we have presumptive evidence of a pituitary disturbance in that they had defective development of the mesenchymal dentin and cementin of the teeth resulting in a premature loss of teeth. The patient himself showed evidence of hypopituitarism in the nature of gynecomastia, absence of a beard and axillary hair and a feminine distribution of pubic hair. It would seem not unlikely, therefore, that a hereditary dyspituitarism played a significant rôle in producing a unilateral mesenchymal bone defect in the form of polyostotic fibrous dysplasia.

SUMMARY

A case of unilateral (right-sided) polyostotic fibrous dysplasia is reported in a boy, aged sixteen. No evidence of hyperparathyroidism was present. A hereditary dyspituitarism was present on the maternal side in the form of familial shortness of stature and premature loss of teeth. Hypopituitarism was present in the patient, being manifested by gynecomastia, absence of a beard and axillary hair, feminine distribution of pubic hair, and a puerile type of voice.

The opinion is advanced that the unilateral involvement of the skeleton is due to an unbalanced chromosomal aberration, the defect being inherited from the maternal side.

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PRACTICAL APPLICATIONS OF BODY SECTION ROENTGENOGRAPHY*

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THE stratigraph, planigraph, tomograph, laminagraph and their modifications have been too fully described elsewhere to require reference to them in this paper. Another type of apparatus has recently come into use in France, the biotome, perfected by Bocage.[1] He was the discoverer of the underlying principle which governs all forms of equipment for carrying out body section roentgenography. Bocage has suggested a term which would include all the different methods for this form of roentgenography. This term is *radiotomie*, which can be readily Anglicized into *radiotomy*. His apparatus employs a coordinated, circular movement of tube and film, and this is done in the vertical position. In this connection it should be said that there are many objections to those types of apparatus, the tomograph and laminagraph, which can be used only with the patient recumbent. This objection is scarcely valid, for the stratigraph, planigraph, and biotome cannot be used with patients incapable of assuming the erect position. All types of apparatus for body section roentgenography disperse the shadows of overlying and underlying structures. The greater the symmetry of this dispersion, the clearer will be the roentgenogram. With more compound movement of tube and film there is more symmetrical dispersion of unwanted shadows.

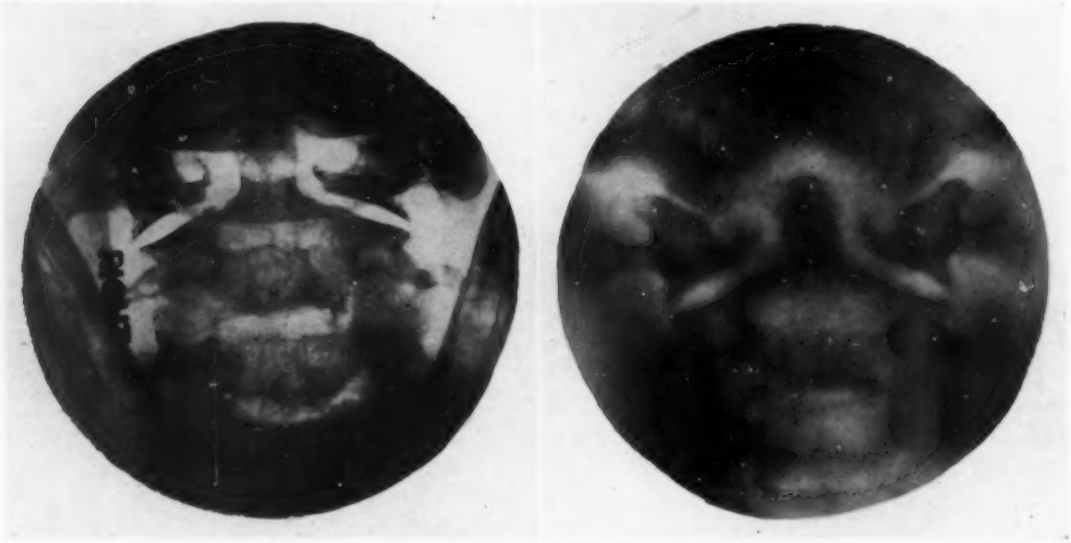

FIG. 1. *Left:* Conventional film of atlas. Normal. *Right:* Laminagram of same. Note occipito-atlantal joint.

In body section roentgenography two things are accomplished: the dispersion of unwanted shadows just referred to, and the development of the minimum of density contrast in a thin layer of tissue. Dispersion of unwanted shadows is naturally more valuable where there is the largest number

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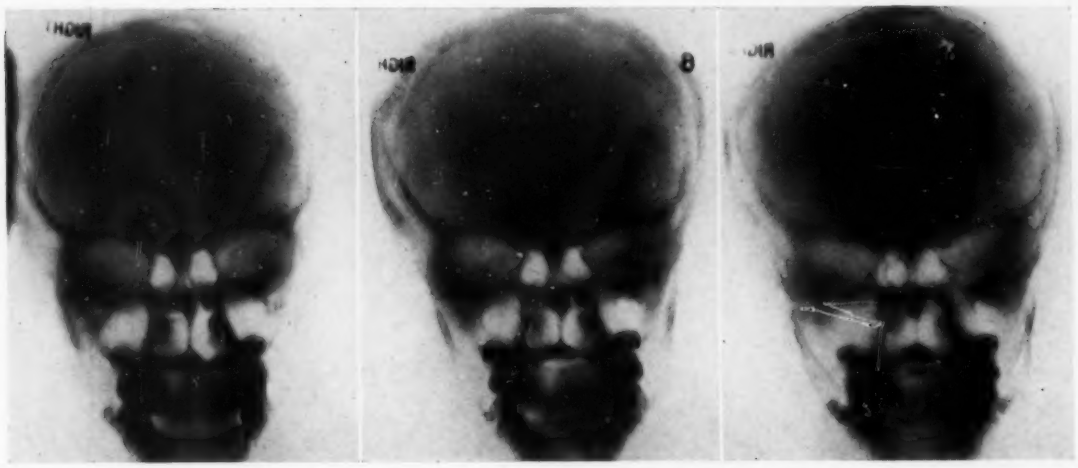

Fig. 2. Laminagrams of paranasal sinuses at 5, 6 and 7 cm. from the plane of the face. At 5 cm. the anterior ethmoid cells are clearly shown, at 6 cm. the posterior ethmoid cells, and at 7 cm. the sphenoid cells. These are optimum planes established by sectioning through the head of a cadaver.

of normal or pathological structures overlying and underlying the area under investigation, and it is of less value with decrease in the number of such structures (Fig. 1). The thickness of the layer investigated with body section roentgenography is a function of the amplitude of excursion of film and tube during the exposure. By increasing their excursion a minimum thickness of layer is assured, thereby bringing out the least contrast in density. These two fundamental facts have a bearing on the practical application of body section roentgenography.

In twenty-eight months of operation of the laminagraph, 1,069 patients have been examined, an average of a little more than one per diem. It must be stated that many of the early cases were examined chiefly to discover the usefulness of this kind of examination. To some extent this is still being done, but the great majority of the cases were laminagraphed because of failure of other methods of examination.

Unwanted shadows produced by a pathological process have, in our experience, been most frequent in the respiratory tract. In certain of its portions there are a number of normal structures the shadows of which it is desirable to eliminate, for example the bones overlying and underlying the paranasal sinuses (Fig. 2), the ribs and sternum in the chest, and the spine in the case of the larynx (Fig. 3).

We have made 372 laminagraphic examinations of the chest and have found cavi-

Fig. 3. Laminagram of larynx. Almost complete occlusion by carcinoma.

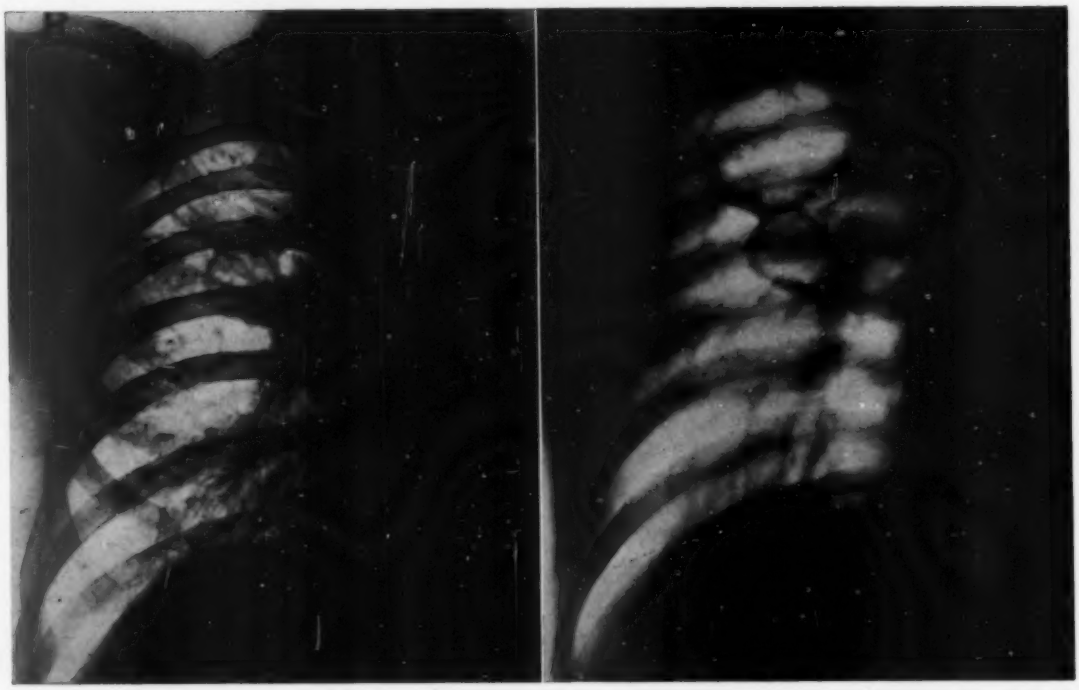

Fig. 4. Pulmonary tuberculosis. *Left:* Conventional film of chest. Suggestion of cavity. *Right:* Laminagram of same patient shows deep-lying cavitation within the lung.

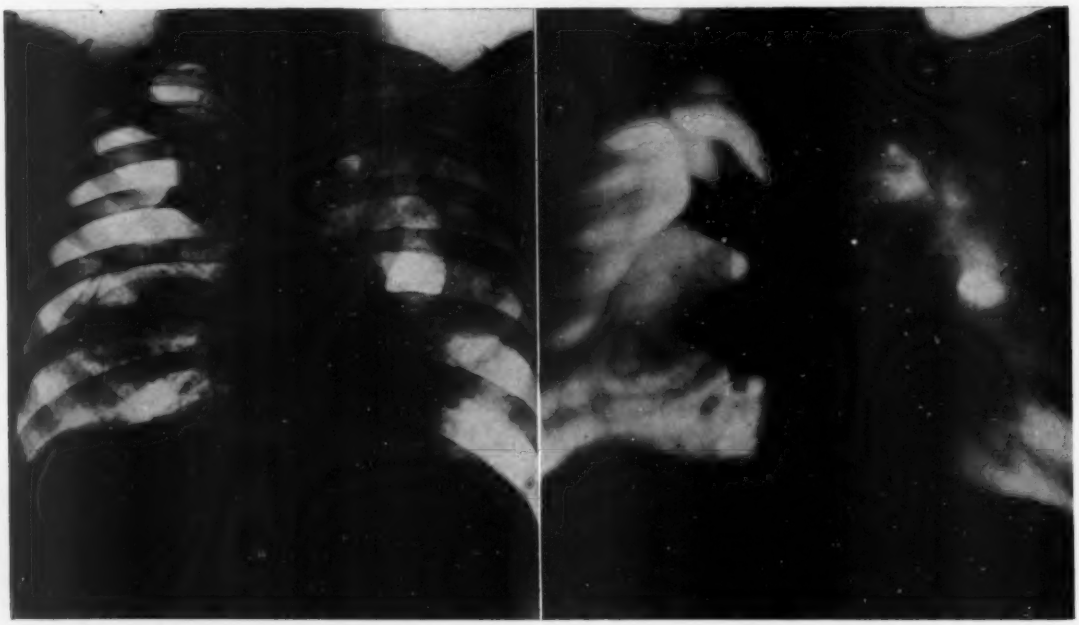

Fig. 5. Pulmonary tuberculosis. *Left:* Conventional film. Therapeutic pneumothorax. Incomplete collapse. *Right:* Laminagram shows cavities in uncollapsed portion of right upper lobe and also in the lower lobe.

ties and consolidations in the lungs which were not apparent either roentgenoscopically or in conventional films (Figs. 4 and 5). The method has been of little value in early acute disease in the lungs. However, excavation has been shown where there was minimal change (Fig. 6). It is undoubtedly true that the absence of grosser changes, such as cavity and consolidation, can be established with the same degree of accuracy as their presence.

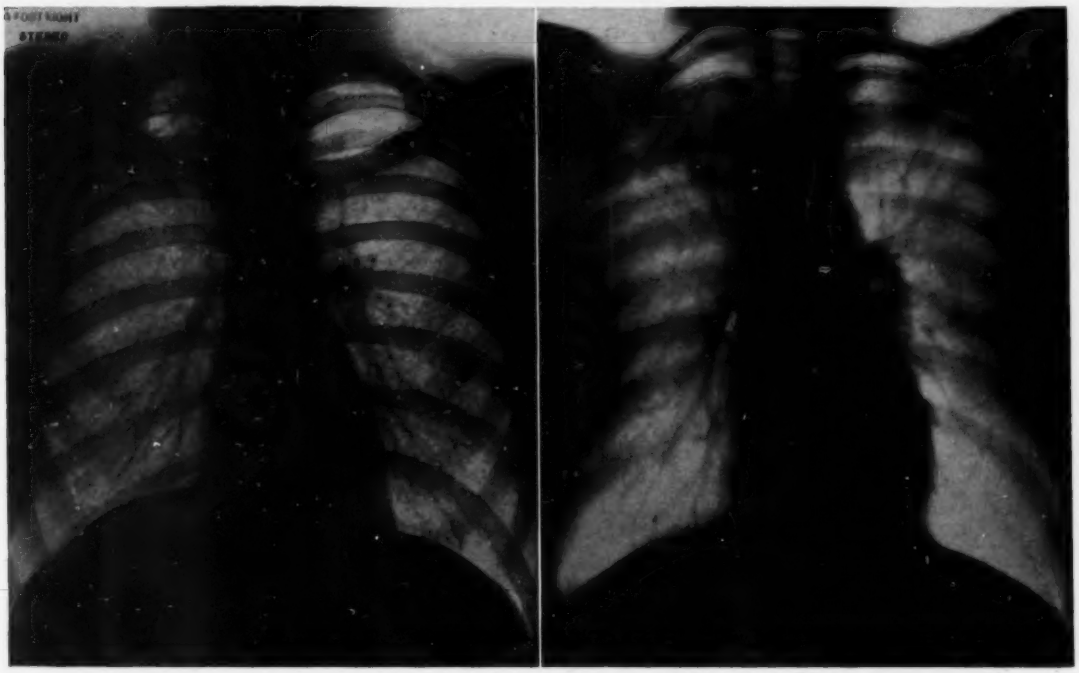

Fig. 6. Examination made because of suspected silicosis. *Left:* Conventional film. *Right:* Laminagram shows multiple cavitation, right apex. Subsequently tubercle bacilli were found in the sputum.

Laminagraphic examination of the paranasal sinuses has been very valuable to otolaryngologists and is becoming increasingly so. This is particularly true of the ethmoid and sphenoid groups of cells. We found that by making laminagraphic sections through the paranasal sinuses on an embalmed head, with sections made through the head at the laminagraphic levels, there was an accuracy which, for all practical purposes was complete, i.e., the structures seen in the laminagrams were easily identified in the sawed sections. The value of the laminagraph in retrobulbar neuritis of undetermined origin has been fully described by Cone, Moore and Dean.[2]

Next to the respiratory tract our experience has been that laminagrams of the skeleton are particularly useful in its axial portion (Figs. 7 and 8). For some reason, probably because of poor selection of cases or insufficient understanding of the application of the laminagraph, it has not been of value in the examination of the vault of the skull, intracranial tumors, or the study of the sella turcica except for the floor of this structure. Below this level it has been of the greatest value, particularly in the case of the ascending ramus of the mandible and its temporal joint, there having been 175 such examinations (Fig. 9). For the joint itself, there is almost routine demand for laminagrams by the oral and dental surgeons. In the case of other portions of the temporal bone, we have not found a great deal of use in studying its pneumatic structure, but the laminagram has been of the greatest value in determining the existence of occlusion or enlargement of the auditory

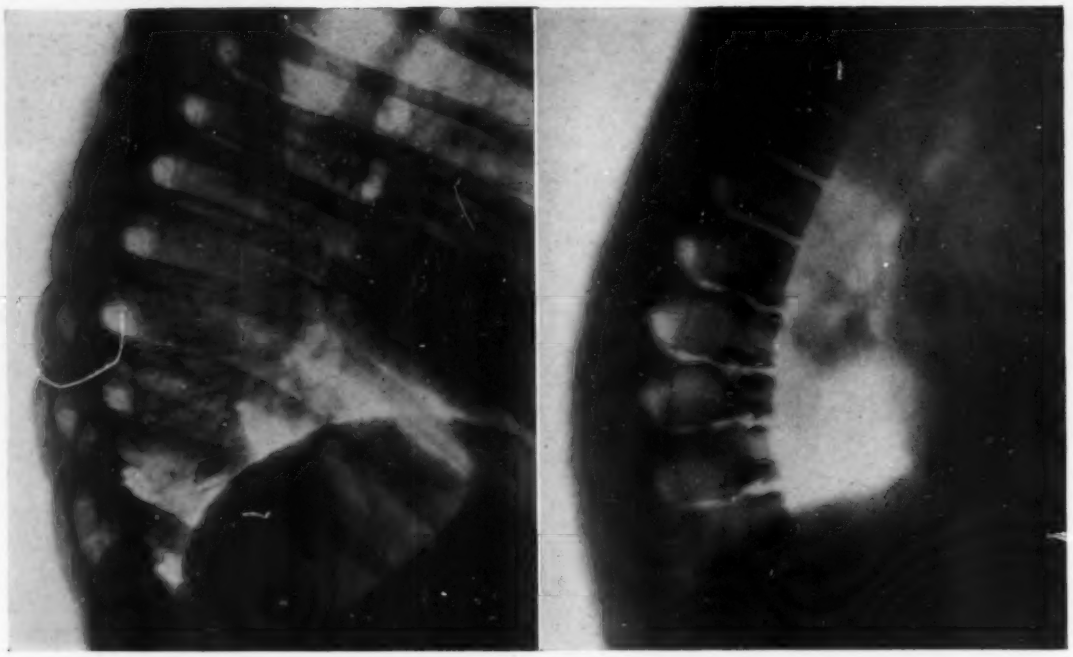

Fig. 7. *Left:* Conventional film of dorsal spine. *Right:* Laminagram of same shows osteochondritis deformans.

canals (Fig. 10). However, this is necessarily a limited field because changes in the canals are of uncommon occurrence. In the bones of the face, except as noted, laminagrams have not been of particular value, but they should be if, through a pathological process, there are confusing overlying structures or in a similar condition brought about by trauma. So far we have not shown anything in the case of the optic foramina, but should they be enlarged, destroyed, or occluded, laminagrams should show such changes.

Fig. 8. Laminagram of manubrium sterni with central destructive lesion.

The value of body section roentgenography in the remaining portions of the axial skeleton depends on the region under investigation. The first three vertebrae can only be truly studied and understood roentgenographically with the body section method (see Fig. 1). Below this point its value decreases rapidly, and it is helpful chiefly in the anteroposterior projection. For some reason, probably through faulty technique or perhaps because of the distance of the cervical spine from the film, lateral examinations of the cervical spine have not been fruitful.

In the dorsal spine we have substituted the laminagraphic for the routine lateral view, for here the fundamental principle of this type of examination comes into play.

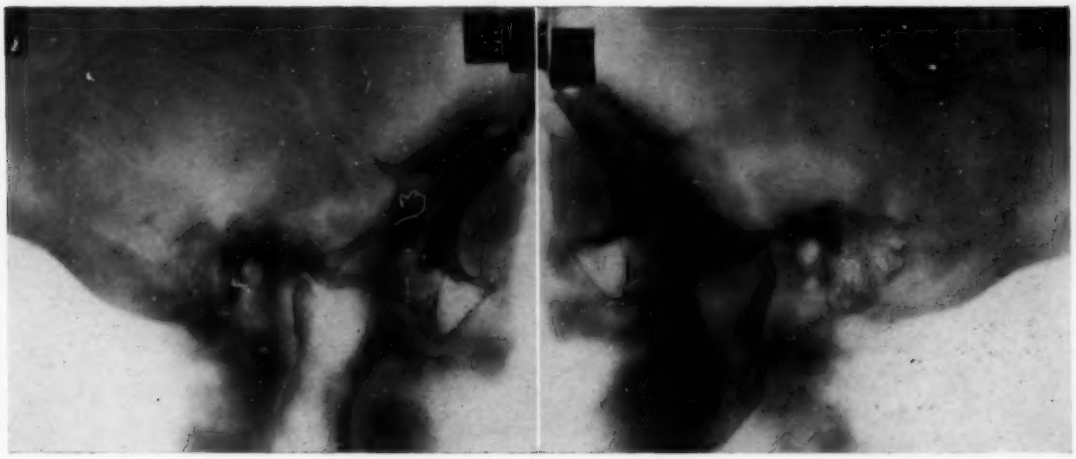

Fig. 9. Laminagrams of temporomandibular joint, jaws open. *Left:* Practically normal. *Right:* Undeveloped mandibular condyle. Thinning of the anterior wall of the auditory meatus.

The shadows of the backward curvature of the ribs on the two sides and the lung markings are so completely obliterated that the bodies and the articulating and spinous processes of the vertebrae are unobscured (see Fig. 7). In the case of the ribs the laminagraph has not been of great value, though it should demonstrate small or early central lesions. However, we have not succeeded in doing this.

Body section roentgenography is the only satisfactory method of examining the sternum and its articulations with the clavicles. The lumbar spine, because of the lack of overlying, confusing shadows, is not a particularly favorable region for this type of investigation either in the lateral or anteroposterior projection. The sacrum can be investigated in this way in the lateral projection to some advantage because the shadows of the innominate bones on either side of these vertebrae are shifted.

In the bones of the extremities, except for developing slight density contrast, such as would be produced by early central lesions, the method has not proved of great value. In the case of a tumor of the bone of an extremity with a great deal of bone production, much information might be secured from laminagrams. These statements apply with equal force to the irregular bones of the appendicular skeleton,

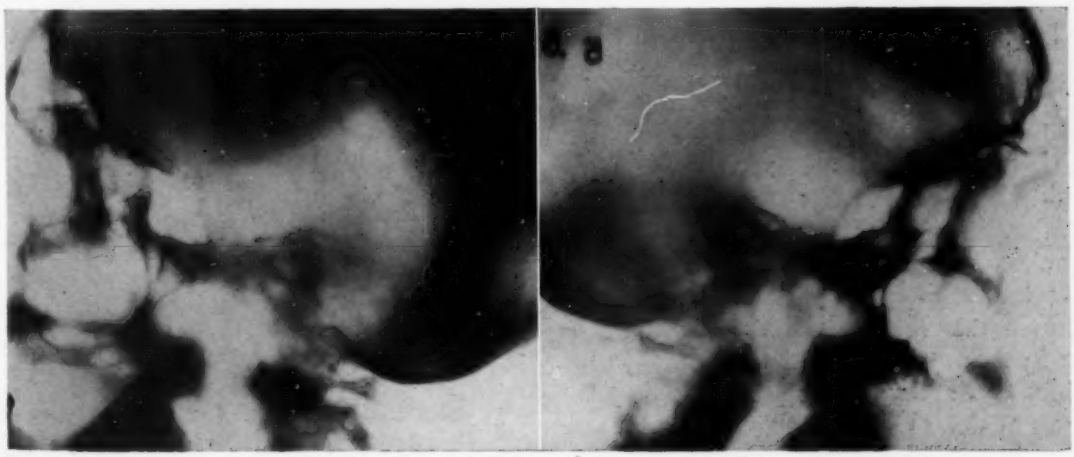

Fig. 10. Laminagrams of internal auditory meati. *Left:* Enlarged internal auditory meatus. Eighth nerve tumor. Confirmed by operation. *Right:* Opposite side. Normal.

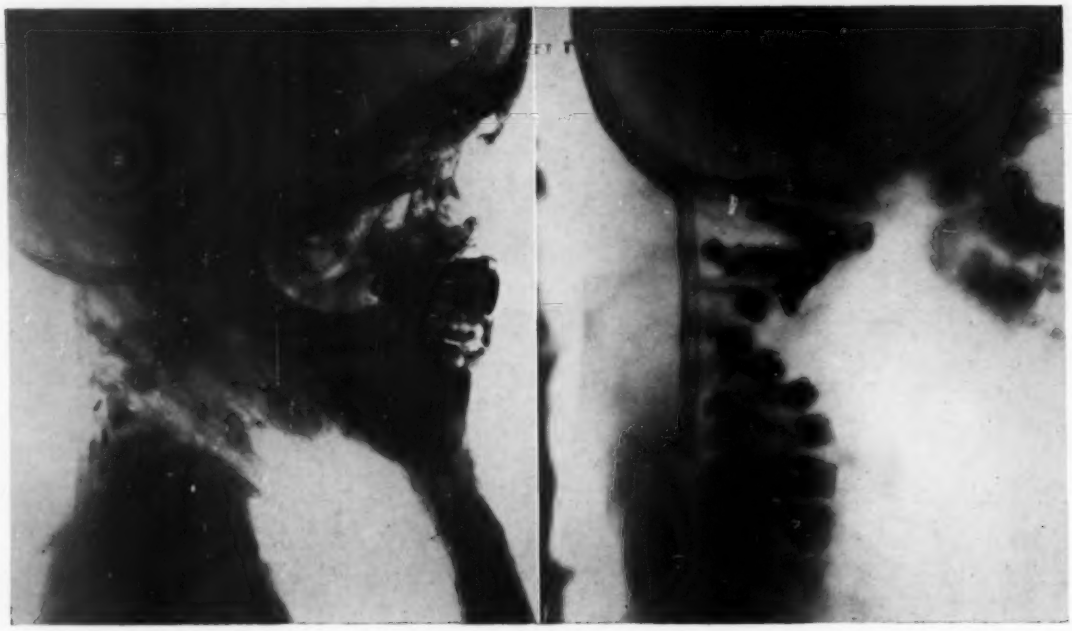

Fig. 11. Destructive lesion of the bodies of the cervical vertebrae. *Left:* Conventional film through plaster cast. *Right:* Laminagram of same through cast. Note bone graft in position.

scapulae, clavicles and innominate bones.

Reference has been made to certain of the joints of the axial skeleton, the temporomandibular and sternoclavicular joints. We have occasionally found laminagrams to be of value in some of the joints of the appendicular skeleton where the conditions of superimposition of structures or minimal contrast in density were fulfilled. It is useful in patients in plaster casts (Fig. 11).

In the case of the alimentary tract we have not encountered a case in which the laminagraphic examination was of value. However, the shadow of the spine overlying any portion of the alimentary tract can be blurred out. We have had no occasion to see that this type of investigation would be of help in the study of the gallbladder. What has been said about the alimentary tract applies also to the urinary tract, but laminagrams can undoubtedly be useful in puzzling cases of unusual calcification in this system. In the abdomen, as a whole, this statement is also true, but we have not demonstrated any particular use except in discovering abdominal aneurysms. Ryan[3] of New York has found laminagrams to be of great help in the investigation of kidney tumors.

Generally speaking, body section roentgenography is of little use in the study of soft tissues, as has been noted above. However, it has outlined aneurysms other than the ones already mentioned and should be of use where there is a minimal density contrast, for example in the soft tissues of an extremity.

In conclusion, it can be said that body section roentgenography, regardless of the type or principle governing the apparatus used, is no longer in the experimental stage. On the contrary, it is so practical that it amply repays the roentgenolgist for the expense involved and the labor of acquiring a new technique.

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BONE CHANGES IN LEUKEMIA

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IN THE last few years, some workers, especially Feer, Fuchs, Smith, and Willi, have been drawing our attention to the complications of the bones and joints in juvenile leukemia. So far, only a few articles have been published, particularly as regards myeloid leukemia, and hardly any roentgenological or pathological reports have been available. Lately, however, we have been able to follow up 2 such cases of juvenile leukemia, also 1 case in an adult, which we should like to discuss.

Case 1. F. I., aged eight, the fifth child of healthy parents, was admitted to the hospital on October 4, 1937. Three of his brothers and sisters, including twins, have died. Two are alive and healthy. On September 1, 1937, the patient developed tonsillitis and had since been complaining of pains in the right thigh and right arm; the temperature had been consistently subnormal. The child was rather frail and pallid, the conjunctivae had a subicteric tinge and there were small petechiae in the right groin and a hematoma in the right thigh, the distal part of which was slightly swollen and tender on pressure. Spleen and liver were enlarged, and there were axillary and inguinal glands, some of which were 1 inch in diameter. The urine showed nothing abnormal. A roentgenogram showed a calcified primary focus in the right lung. Blood Wassermann reaction was negative. Blood count: leukocytes 2,100, erythrocytes 2,250,000, hemoglobin (Sahli) 48, thrombocytes 63,000, reticulocytes 5 per cent. Bleeding time and coagulation time, normal. The differential count was as follows: eosinophiles 1 per cent, myelocytes 1 per cent, immature polymorphonuclear neutrophiles 4 per cent, staff cells 8 per cent, polymorphonuclear neutrophiles 22 per cent, monocytes 4 per cent, lymphocytes 40 per cent, and rather large round cells with a small rim of basophile protoplasm and a round and slightly indented nucleus 20 per cent. There were offshoots and vacuoles in the protoplasm of the "round cells," the nucleus of which was rich in chromatin and contained one or more nucleoli. Nearly all these cells showed a negative peroxydase reaction and they gave the impression of being small myeloblasts. Repeated blood counts were made, but the leukocyte count was always low with one exception only, of 6,100; the average count was 3,060. Neither did the red cell count show any variations. There was always hyperchromic anemia. Repeated differential counts showed at different times myeloblasts, even up to 16 per cent and between 45 and 82 per cent of round cells, lymphocytes and lymphocyte-like cells.

A sternal puncture was made and a watery, yellow marrow containing large lymphoid cells was obtained. This and all the other findings made the diagnosis of an aleukemic myeloid leukemia a probable one. Only a few of these cells showed a positive oxydase reaction, and some of them resembled paramyeloblasts.

Owing to the rather severe anemia and the steady decrease of the leukocytes to as low as 800, a blood transfusion was given. The donor was the child's mother whose blood group was O, and 200 cc. of citrated blood was transfused into the right saphenous vein of the child whose blood group was A. The general condition improved temporarily, the pains in the legs subsided and the spleen decreased in size. In addition, for two weeks the child was given 5 cc. dipron, also, later on, liver preparations twice weekly. The temperature was usually subfebrile, only occasionally as high as 101.3° F. Repeated blood cultures were sterile. However, pathogenic *Staphylococcus aureus* could be grown from the fluid obtained by sternal puncture.* Klima, and recently, Baserga and Barbagallo, have stressed the importance of the bone marrow culture should the blood culture be negative. After repeated sternal punctures, the marrow, which was watery at first, assumed a red color. Several films, made from the marrow, showed increasing numbers of myelocytes, promyelocytes and nucleated red cells, but large lymphoid cells were always more numerous. These lymphoid cells stained partly when subjected to the peroxydase reaction. They were thus classified as myeloblasts. The blood

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Fig. 1. Round destructive focus in the trochlea astragali. The focus has a clear outline.

Fig. 2. Extreme decalcification of the tarsal bones with irregular arrangement, and very distinct and conspicuous rarefaction of the cellular trabeculae.

transfusions were repeated and each time there was some obvious but only temporary improvement. On November 20, a small swelling of the left ankle joint was discovered just below the outer malleolus; after a few days, however, it subsided. On January 10, the swelling reappeared at the same place. This time it gave rise to rather severe pains so that the child could not stand. The knee and ankle reflexes were increased. A roentgenogram was taken.

Roentgen Report. There is a round focus of destruction of a very clear and sharp outline, the size of a pea, in the trochlea of the left astragalus near the joint (Fig. 1). The bones of the

Fig. 3. Multiple tiny punched-out foci of destruction, the size of a pinhead, with eburnation of the surrounding bone in the distal epiphysis of the femur.

foot are decalcified to a high degree; the cellular trabeculae are irregular and rarefied, mainly those in the distal bones which are transparent. Just above the epiphysis the distal metaphyses of the tibia are of the same absolute transparency (Fig. 2). There are small punched-out foci of destruction no larger than a pinhead in the distal epiphyses of both femurs with eburnization of the surrounding bone (Fig. 3).

Later, the clinical findings and the blood counts hardly changed in spite of repeated blood transfusions. The child was discharged on February 22, at the request of the father. Ac-

cording to the parents, there was no change in the general condition till April, when there was a deterioration. The child died on April 9.

Discussion. A boy, aged eight, was suffering from a subacute aleukemic myeloid leukemia which ran a typical course and rather resembled a symptomatic aleukia such as has been described by Grosser. After four months' illness, he developed a swelling of the ankle joint which was caused by secondary changes in the bones due to the leukemia, and a typical roentgen finding was obtained. Like Fuchs, we were also able to demonstrate from our material the increasing incidence of such leukemias within the last few years; it is significant, too, that at the same time the number of cases with secondary changes in the bones and joints has increased. A changed state of immunity or bacteria of low virulence may possibly prove to be the explanation of those foci in the bones; similarly, syphilis or tuberculosis appears to give a better prognosis once there appear syphilitic or tuberculous changes in the bones.

Case II. The patient was a girl, aged three, the second child of healthy parents. Two sisters of the mother had died of tuberculosis. On August 14, 1936, this girl was admitted to the surgical unit of the Children's Hospital; she had been complaining of pain in the right hip for a week. On examination, passive movements in the right hip joint were limited to a slight extent; active movements were hardly possible; the child was frail and pallid. The roentgenogram showed a double coxa valga. Tuberculin tests were negative. The right hip was encased in plaster of paris, and the child was discharged. This plaster, having been removed, the child did not complain of pain for a time. She was re-admitted on November 16. This time there was severe anemia, spleen and liver were enlarged, and there were glands the size of a pea and smaller in the axilla and behind the sternoid muscle. The clinical findings for the hip joint were the same as before. Tuberculin tests were again negative. A roentgenogram showed the medial and lateral parts of the head of the femur and the adjacent part of the neck to be diffusely transparent. The blood count was most illuminating also. Leukocytes, 76,900; erythrocytes, 2,780,000; thrombocytes, 27,800; hemoglobin (Sahli), 63. Differential count: large lymphoid cells, most of which gave the peroxydase reaction, amounted to 80 per cent, promyelocytes 1 per cent, myelocytes 1 per cent, polymorphonuclear neutrophiles 1 per cent, lymphocytes 17 per cent. Bleeding time two minutes, coagulation time three and a half minutes. The temperature was consistently subfebrile. The girl was discharged after one week, by the parent's desire. We heard that from time to time she complained of pain in the hip. Later on, she developed swellings and pains in other joints, and was thus confined to bed until she died on April 30. The signs in the bone as shown by the roentgenogram were no doubt of a leukemic nature in this case also.

Discussion. A girl, aged three, was admitted complaining of pain in the right hip. The case appeared to be one of coxa valga and was treated accordingly with a plaster of paris cast. It was only three months after her first admission that the affection of the joint was found to be due to leukemia. Willi, Trusen, and Erb found in their pathological studies of "lymphadenosis with similar roentgen findings" that these foci in the bones were formed by proliferation in the marrow, in the haversian canals and in the periosteum. These foci give rise to pressure atrophy and thus to rarefaction of the cellular trabeculae in the marrow and to the destruction of the cortex. The foci are usually seen in the metaphyses (Feer and others).

Case III. The patient was a man, aged fifty-seven, in a rather cachetic state. He came to the hospital for the first time in July, 1937; at that time his spleen was greatly increased in size, extending two fingerbreadths to the right beyond the midline and also into the great pelvis. The blood count was normal. Pyelogram and barium meal showed nothing abnormal; there were no palpable glands.

A tentative diagnosis of aleukemic myeloid leukemia was made and roentgen therapy was begun. After small doses of radiation were applied, the spleen decreased in size and soon there was no tumor palpable. Very soon his general condition was quite normal. Each year, however, the patient had a relapse, but roentgen therapy was always successful. The fact

Fig. 4. Peripheral erosion on the distal metaphyses of the metacarpal bones and the proximal metaphyses of the proximal phalanges.

that the tumor always subsided after roentgen irradiation had been carried out made the diagnosis of a leukemia a most likely one. But it was not until September 29, 1938, that a blood count showed the following changes: erythrocytes 4,800,000, hemoglobin (Sahli) 90 per cent, leukocytes 3,200. Differential count: staff cells 4 per cent, polymorphonuclear neutrophiles 50 per cent, lymphocytes 30 per cent, eosinophiles 1 per cent, mast cells 1 per cent, monocytes 8 per cent, myelocytes 3 per cent, metamyelocytes 1 per cent, special cells 2 per cent.*

In November, the spleen again became enlarged and the patient developed intermittent fever. At that time, he told us that he had been complaining of pains in the lumbar region ever since May, 1938; these pains extended into the lateral aspect of both thighs, especially the right one.

Roentgen report of the lumbar vertebrae, December 12, 1938. Several foci of destruction in the spongiosa of the fourth lumbar vertebra with collapse of the vertebral body which assumed the shape of a wedge pointing forward and to the right (Figs. 5 and 6).

We gave altogether 2,400 r in daily doses of 200 r. In the course of this treatment, the pains subsided and the temperature became normal.

Discussion. A man, aged fifty-seven, suffering for three years from a large splenic tumor but at the same time having a normal blood count, was seen from time to time and treated with roentgen radiation. After three years, he developed pains in the lumbar region extending into both thighs; soon afterwards the blood and differential count showed changes rather typical of an aleukemic myeloid leukemia. By roentgenogram, foci of destruction and a fracture due to compression were demonstrated in the fourth lumbar vertebra.

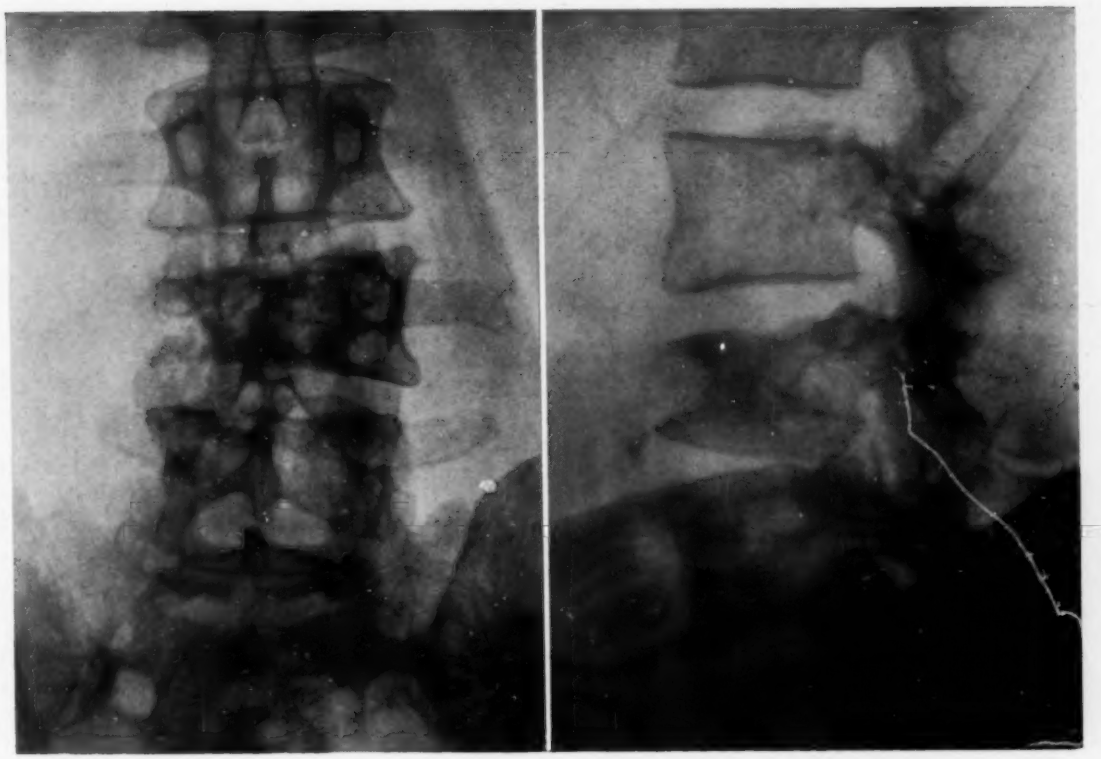
By comparing the roentgen reports just mentioned with what has been described in the literature, the following groups can be demonstrated:

I. Local proliferations in the bone marrow with erosion of the cellular trabeculae; necrosis is also seen occasionally. These give rise to central cavity formations shown very clearly in our case describing the changes in the astragalus. In Case 1, diffuse infiltrations of the bone were demonstrated in the distal metaphyses of the tibiae, adjacent to the epiphysis. There is little doubt, also, that the extreme decalcifications and erosions of the cellular trabeculae of the tarsal bones (and also the vertebral changes in Case III) were caused by the myeloleukemic cell proliferations in the marrow. In this group of leukemic bony changes spontaneous fractures may occur (Figs. 5 and 6).

II. Periosteal proliferations. Sometimes the superficial layer of the periosteum is separated from the corticalis by a broad layer of the reticular tissue. The question regarding the peripheral erosion of the bone-cortico-periosteal foci belongs to this category, as shown by Willi's Case 1 (see Fig. 4).*

* Dr. E. Adler.

* We have to thank Professor Fanconi and Dr. Willi for their kind permission to use this illustration.



Figs. 5 and 6. Local or circumscribed destruction of the spongiosa and collapse of the body of the fourth lumbar vertebra.

III. In this group, the bone changes due to leukemia give the impression of sclerosis. As seen in our case, a reaction of this kind surrounding tiny clearly outlined foci of destruction is demonstrated in the distal epiphyses of the two femurs. The close relationship between destructive foci and the new formation of bone seems likely to confirm Paschlau's theory that the transformation of myeloid tissue into fibrous tissue results in new bone formation.

Schmorl and Assmann stressed the fact that bones with very distinct osteosclerotic changes also showed a corresponding fibrous change of the medullary tissue. These two processes, on the one hand, the proliferations and fibrous changes, and on the other, substitution of bone for fibrous tissue can be watched stage by stage and also at the same time, and the conclusion is justified that the formation of fibrous tissue and bone represents the result which could be regarded as a cicatrization of those previous proliferations which, however, were not viable.

The case described by Teufel shows the combination of the periosteal and osteosclerotic form without any destructive changes.

One fact, however, is important. The roentgenograms alone are not sufficient to diagnose leukemic changes. Referring to Group 1, we obtain the same result in cases of multiple myeloma as either local foci or diffuse infiltrations. We mention this especially as recently we had a similar case in a girl aged two. However, multiple myeloma in children is rather rare; according to Schaffa, only 8 cases are known. For the findings in this case, we refer the reader to Schaffa's published article.

Carcinoma metastases should also be mentioned, especially the multiple osteolytic foci most frequently seen in cases of cancer of the breast, bronchial carcinoma and hypernephroma; but these are prac-

tically non-existent in children. Tuberculosis affecting the central part of the bone produces a roentgen picture similar to the one shown in our first case of the destructive focus clearly outlined in the astragalus. In other inflammatory conditions, foci of clear and of obscure outline, also diffuse infiltrations, can be seen. Very rarely, lymphogranulomatosis gives rise to destructive changes in the bones. Finally, as far as the differential diagnosis is concerned, one would have to consider the osteoporotic and sclerotic variation of Paget's disease, Gaucher's disease and enchondromatosis.

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A ROENTGENOLOGIC STUDY OF THE HIP JOINT OF THE INFANT IN THE FIRST TWELVE MONTHS OF LIFE

WITH REFERENCE TO EARLY DIAGNOSIS OF ITS CONGENITAL DISLOCATION*

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THIS study was begun out of necessity. A child of two was seen in whom bilateral congenital dislocation of the hip joint was recognized by her curious gait. This is the usual clinical experience, which in this case should have been avoided since the child had been delivered by an obstetrician of wide experience. Yet, he denied the fact that the child had this congenital dislocation and insisted to the parents that he had never had such an unfortunate incident befall him in his practice.

Early diagnosis and treatment are being stressed, since they seem to make so much difference in the end-result.

It is necessary to educate the medical profession that this dislocation may be recognized early. This campaign has been successful in North Italy, where the dislocation is common.

The clinical signs have been emphasized by Putti, Jaeger and Freiberg. Simple observation, especially in the unilateral dislocation, should indicate the need for orthopedic examination. The roentgenograms should be conclusive of the diagnosis of congenital dislocation of the hip. Since this is so, the roentgen anatomy of the normal hip joint of the infant needs study, especially in the first twelve months of life.

It is not necessary to examine a large number of such roentgenograms since the changes in development month by month are slight. The hip joints of 34 infants were examined. A few stereoscopic roentgenograms were taken but were unsatisfactory because the child would not lie quietly. A device to hold the child rigid was thought of, but it did not seem worth while since so little is gained by stereoscopic study.

An important point in this study was the examination of the roentgenograms of the flexed and adducted hip, pressure being made against the knee in the line of the adducted femur. This position, it was felt, should be an ideal one to indicate dislocation, since it is the position in which dislocation is likely to occur.

Abdominal roentgenograms of women in the later months of pregnancy were examined to study the fetal hip joint.

A few roentgenograms of congenital dislocation of the hip diagnosed in the first year of life were also examined.

THE NORMAL HIP JOINT OF THE INFANT UP TO TWELVE MONTHS OF AGE

The hip joint is described beginning with that of an infant twenty-six days old. The description is amended as changes are seen in the succeeding months of growth.

The *acetabulum* or the socket of the hip joint is composed of two principal parts, an *upper* or *iliac part*, and a *lower part* which is made up of two bony elements, *ischial* and *pubic*, which are joined together as the pincers of a crab. These pincers border the obturator foramen almost completely.

The ischial part is obliquely vertical and medial, while the pubic part is obliquely

* From the New York Dispensary, New York City.

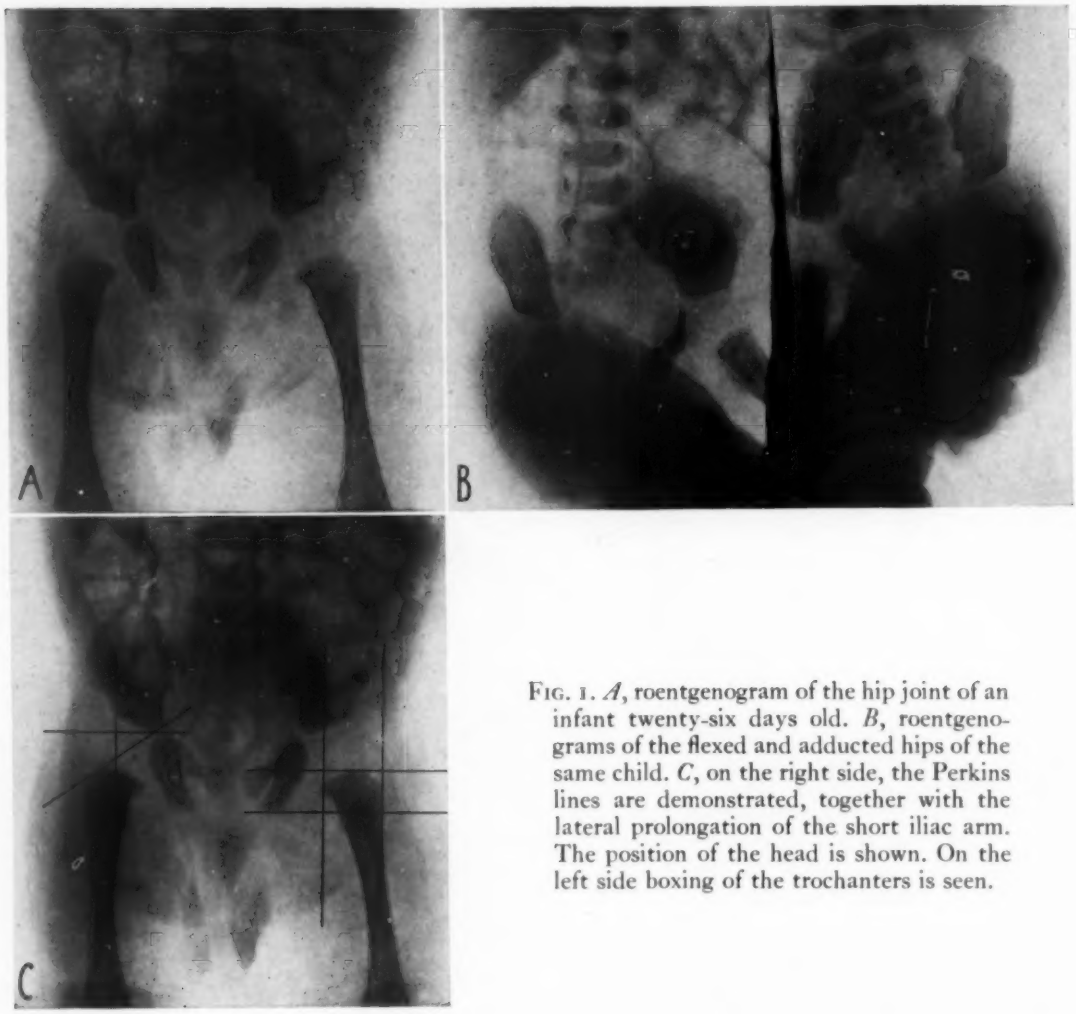

FIG. 1. *A*, roentgenogram of the hip joint of an infant twenty-six days old. *B*, roentgenograms of the flexed and adducted hips of the same child. *C*, on the right side, the Perkins lines are demonstrated, together with the lateral prolongation of the short iliac arm. The position of the head is shown. On the left side boxing of the trochanters is seen.

horizontal and medial in direction. The ischial part is comma shaped and usually overlaps the most superior pubic part at the level of the acetabulum. This is not always true, since the pubic part may rise above the ischial, depending on the angle of the ray. The pubic part is dumbbell shaped, its most medial rounded end forming one-half of the symphysis pubis. The most medial part of the ischiopubic junction (which is not closed since it is still cartilaginous) is formed by an inferior prolongation of this medial part. This shape of the pubis is well seen after six months of age, when the bony outlines are clear cut. The inferior edge of the superior ramus of the pubis is concave, the superior slightly convex. The inferior pubic ramus meets the rounded medial part of the pubis at an angle which is less than a right angle.

The lower part of the socket seems mainly ischial. It is oval, obliquely vertical and medial in its long axis. It is apparent that the ischial part is the arthrodial part of the socket. After the first month, the ischial part shows a division into two parts, which is particularly well seen after the age of six months. The upper half of the bone is arthrodial and is separated from the lower thinner half by an increasingly distinct step or waist. The tuberosity of the ischium is poorly indicated in the early months of life. It becomes increasingly distinct after four to six months of age, and

is accentuated when the inferior ischial ramus develops.

At twenty-two months of age, it is appreciated that the pubic part forms the deepest and most medial part of the socket.

Two ischial lines are accented. The *lateral accented line* marks the ischial edge of the socket. The other, more strongly accented, begins at the most medial border of the ischium superiorly, runs somewhat medial to the medial ischial edge, and ends a little below the level of junction of ischium and pubis. This is the *medial accented line*. These vertical lines are fairly parallel and their convexity is directed medially and not laterally. The appearance of these two lines is not always the same, and this depends on the angle of the ray. The dissociation of the pubis from the ischium in various angles indicates that these lines are ischial, and that the medial accented line is not the junction of pubis and ischium. This is well seen in a face-on view of the pubis as it joins the ischium. These lines are roentgenographic phenomena and are the equivalent of the "tear drop" seen in the hip of later age. The two lines have as yet not joined inferiorly to give the "tear drop" effect.

FIG. 2. Anteroposterior roentgenogram of the hip joint of an infant six weeks old.

FIG. 3. Anteroposterior roentgenogram of the hip joint of an infant three months old. The bilateral presence of the capital epiphysis is noted. The roentgenogram is marked to indicate the various anatomical parts: *1*, iliac wing; *2*, iliac roof or long iliac arm; *3*, short iliac arm; *4*, Y-cartilage interval; *5*, arthrodial part of the ischium; *6*, tuberosity of the ischium; *7*, inferior ramus of the ischium; *8*, pubic bone; *9*, that part of the pubic bone entering into the symphysis pubis; *10*, inferior pubic ramus; *11*, ischiopubic interval; *12*, symphysis pubis; *13*, medial accented line; *14*, lateral accented line; *15*, capital epiphysis; *16*, epiphyseal plate; *17*, metaphyseal plateau; *18*, medial metaphyseal beak; *19*, greater trochanter; *20*, lesser trochanter; *21*, femoral shaft; *22*, joint space; *23*, obturator foramen.

The iliac part of the socket forms the roof of the acetabulum. The line of the ilium is directed from below and medial to above and lateral. The iliac socket is shallower than the ischial. Its function seems less arthrodial than retentive, that is, as a roof or buttress to keep the head within the socket. The iliac socket is shallower and an increasingly larger part of its articular surface is seen as the infant becomes older, the roof becoming more and more distinct (twenty-two months).

In many of these roentgenograms, esti-

FIG. 4. Roentgenogram of the hip joint of an infant four and a half months old. The capital epiphysis is bilaterally present but is less well developed than the preceding figure.

mation of the *roof angle* was made (Table 1). This angle is called the *acetabular index* by Kleinberg and Lieberman. This angle is always an obtuse one. Rohlederer showed that the roentgenographic estimation of the roof angle of the fetal ilium seemed to vary with the degree of lumbar lordosis. An angle of 26° (116°) in a position of lumbar lordosis was altered to 38° (128°) when the lumbar spine was straightened. The typical picture of the acetabulum in congentital dislocation of the hip was an expression of an absent or inadequate pelvic balance. The roentgenogram was no certain indicator of the course and condition of the bony acetabular roof, or that, in other words, the upper acetabular bony roof was normal. The roentgenograms of the hips of newborn infants were to be critically regarded as regards a normal anatomic structure.

TABLE I

ROOF ANGLES

Age	Right	Left
26 days	113°	102°
1 month	116°	108°
1 month	122°	113°
2 months	112°	113°
2 months	118°	103°
	105°	118°
4 months	114°	121°
4 months	105°	120°
4½ months	120°	110°
5 months	107°	113°
6 months	104°	112°
	97°	116°
6 months	111°	105°
7 months	103°	117°
7 months	101°	123°
10 months	106°	117°
10 months	115°	105°
	110°	116°
10 months	104°	119°
11 months	110°	119°
16 months	124°	103°
?	111°	111°

The *long arm* of the ilium is the iliac roof. The *short arm* of the ilium is the iliac border of the Y-shaped cartilage or the conjugal cartilage of ischium, pubis, and ilium. Its direction, from above and medial to below and lateral, is opposite to the line of iliac roof, which it intersects at about an angle of 90°.

In the first year of life, the Y-shaped cartilage remains clear, the space between the upper and lower parts of this cartilage being roughly 2–3 mm. There is some narrowing of this space in the later months of the first year of life. When the pelvis is centered properly, the Y-shaped cartilage of each side is on the same straight (horizontal) line.

When the capital epiphysis of the femur is absent, the joint space seems large. The metaphysis, that part which later is the neck, is broadened, its most proximal edge being flattened as a *metaphyseal plateau*. There is a transverse bony condensation just beneath this plateau. This plateau slants downward and medially, ending medially in a beak, which is usually rounded but is sometimes squared. The line of the metaphyseal plateau is more or less parallel to the line of the iliac roof. The medial beak is 2–3 mm. from the lower part of the ischial socket in the neutral position of the pelvis. There is rounding of

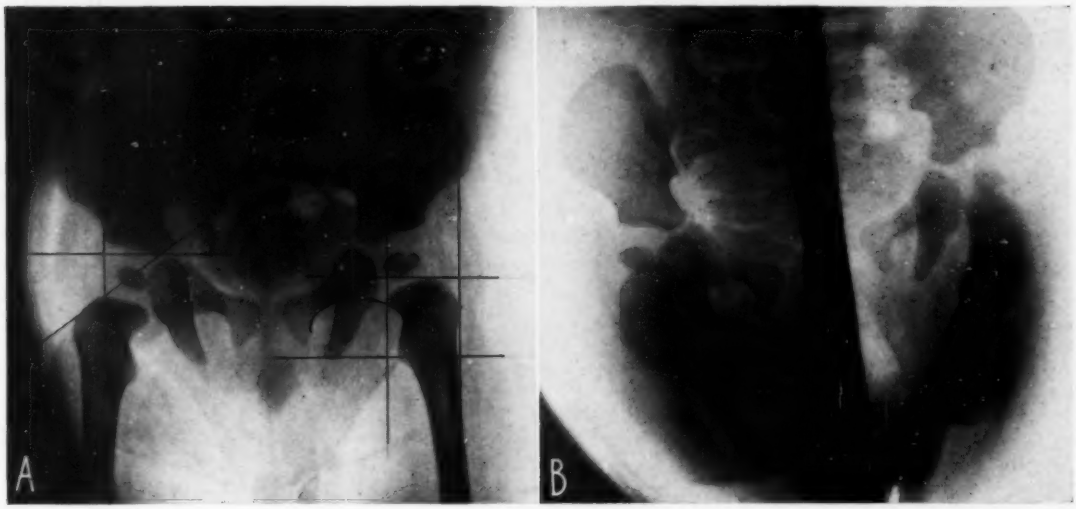

Fig. 5. *A*, roentgenogram of the hip joint of an infant six months old. The capital epiphysis is bilaterally present. The epiphysis has now attained constancy of appearance but not of size. On one side Perkins' lines are shown together with the lateral prolongation of the short iliac arm. On the other side the trochanters are boxed. Shenton's line is shown on that side also. *B*, flexion-adduction views of each hip with proximal push in the line of the femur.

the plateau laterally as it enters into the greater trochanter. The lesser trochanter is indicated medially by a slight convexity, or the region of the lesser trochanter may be bellied out like the breast of a pigeon, especially in external rotation. A concave indentation of varying depth separates it from the beak of the metaphyseal plateau.

There is no definite femoral neck, the metaphysis, which is placed in valgus, being a continuation of the femoral shaft.

It is not difficult to localize the epiphysis so that its position with reference to the socket may be accurately determined. It lies about 4–5 mm. above the mid-part of the metaphyseal plateau, so that the rounded end of a large lead pencil placed at this point localizes the epiphysis exactly. Its relationship to certain arbitrary lines delimits the epiphysis. Four of these may be mentioned, since they were investigated in this work. The first is a line which has not been previously described. It is a downward and lateral prolongation of the short iliac arm. This line inevitably intersects or falls just outside of the capital epiphysis.

The lines which Perkins described are of value since they place the capital epiphysis in the inferomedial quadrant of an arbitrary cross. This cross is formed by the perpendicular intersection of two lines, a perpendicular one dropped from the outer lip of the iliac roof and a horizontal one drawn through the lowest part of the ilium at the junction of the short and long arms.*

Two transverse lines box the trochanters so that the level of each trochanter is fairly accurately determined. The lower horizontal line is tangential to the tip of the ischial tuberosity and intersects the lesser trochanter. It is preferable that both hips be in slight external rotation to bring out the lesser trochanters. The upper horizontal line is tangential to the top of the greater trochanter, that point being chosen which is the junction of the metaphyseal plateau and the greater trochanter. It intersects the epiphyseal plate and the

* We have modified the level of the horizontal line slightly. Perkins drew this line through the lowest part of the inner border of the ilium, the line being at a level a little higher than we have drawn it.

This horizontal line is really part of a larger horizontal line, passing through both acetabula, and which is used commonly to determine the level of the femoral head. The vertical line further delimits the position of the head.

FIG. 6. The hip joint of an infant ten months old.

ischial socket. When the epiphysis is present, it may sometimes intersect it, depending on the size of the epiphysis and its tilt.

The boxing may be completed vertically to determine the distance of the femoral shaft (caput) from the acetabulum. A perpendicular line tangential to the medial beak intersects the inner third of the iliac roof. If the epiphysis is present and is large enough, it may intersect it; if the epiphysis is small, it will lie outside this line. A similar line, tangential to the most prominent part of the greater trochanter, may intersect the iliac wing but usually falls outside of it. Each extremity must be held in a neutral position and the pelvis must be level and centered properly. If pelvic obliquity is present, the lateral perpendicular line will intersect the ilium on the low side of the pelvis and not on the high side. The medial perpendicular line will then intersect the outer half of the iliac roof on the high side. The medial perpendicular line is the more significant one, and it is necessary to avoid marked external rotation to visualize the beak.

Shenton's line is the smooth arc of the upper line of the obturator foramen (pubic part) and the inner line of the medial part of the femoral metaphysis (neck) and upper femoral shaft. The type of curve may vary with the position of the hip but it is important that the arc be a smooth continuous curve. The line is seen best in the neutral position of the hip. The type of curve is affected by forward or oblique tilt of the pelvis, by flexion-adduction position of the hip, and by external rotation of the hip. In external rotation the line is flattened in its obturator part and is more convex laterally in its femoral part.

When the capital epiphysis has appeared, its relationship to the socket is obvious. The capital epiphysis is fairly constantly ossified after six months of age, but this ossification may be noted much earlier as a variable, even at one to two months of age. The lower femoral epiphysis, however, is usually present at birth. The capital epiphysis is oval in shape, placed a variable distance above the center of the metaphyseal plateau, and its long axis is directed downward and medially in the line of the pla-

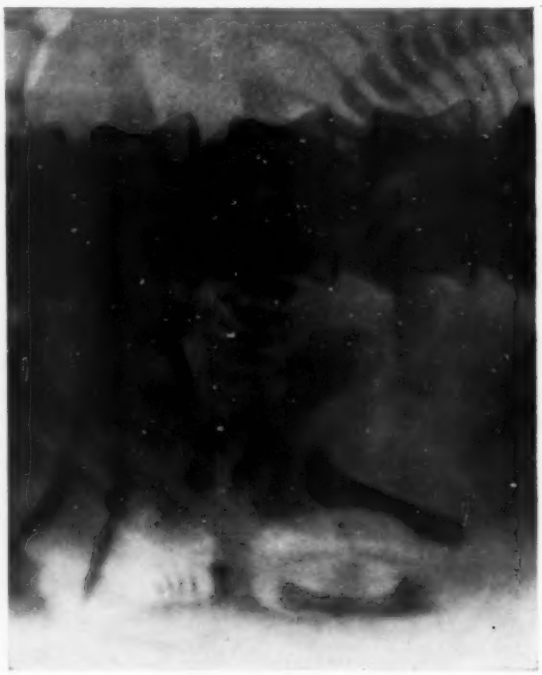

FIG. 7. The roentgenogram of the hip joints of a fetus (in the later months of pregnancy). The right hip in flexion and abduction. The left hip is in flexion. The iliac wing, the acetabulum, and the ischium are fairly well seen.

teau. The width of the epiphyseal plate, and the distance of the head from the acetabulum diminish as the capital epiphysis becomes larger. The epiphysis may rise a little higher than the point of junction of the pubis and ischium, but it is usually at the level of the Y-shaped cartilage or just below it.

Growth of the epiphysis is regular and its trabeculation is smooth and even. In one infant of six months, the outer fourth of the epiphysis was irregular, and divided by a longitudinal line from the inner three-fourths. At six months of age, the epiphysis has attained constancy of appearance but not of size.

The obturator-coxofemoral line (Shenton's line) may now be used for the determination of epiphyseal position with reference to the socket. When the epiphysis is present, it lies outside of this line.

There is increasing development and delineation of bony structure as the child becomes older.

The pelvis may be tilted obliquely, or forward or both. When the roentgenogram is taken, the child must rest firmly and squarely on the table. Obliquity of the pelvis is indicated by asymmetry of the obturator foramina and iliac wings, and by inequality of roof angle, which is greater on the high side. The obturator foramen appears more open on the elevated side of the pelvis. When the pelvis is tilted forward on one side, that side will show a greater frontal view of the ischial socket, rather than a sagittal view.

The soft tissue shadows are important. When the two thighs are together, the two gluteal folds make a single convex line which intersects each femur just above its mid-part. When the child is twisted, the two gluteal curves are dissociated and the intergluteal crease is displaced to one side of the midline. The gluteal fold away from the plate is flatter, longer, less convex, and ends at the flank of the body; the gluteal crease nearer the plate is shorter, more convex, and terminates posteriorly and not laterally. There are two or more thigh creases. Sometimes, the muscle mass of the pelvitrochanteric muscles is seen from origin to insertion. When bony detail is clear, soft tissue detail may not be.

Fig. 8. The roentgenogram of the hip joint of an infant three months old. The left hip is dislocated.

THE EFFECT OF FLEXION-ADDUCTION POSITION OF THE THIGH, WITH PROXIMAL PUSH IN THE LINE OF THE FEMUR

There is some technical difficulty in the roentgenography of the flexed and adducted hip since the hip tends to tilt forward. The adducted side of the pelvis is high. Forward tilt of the pelvis and pelvic obliquity are here associated.

It is much easier to roentgenograph each hip separately, rather than the crossed hips simultaneously. The latter position does not give enough flexion and adduction. The proper degree of adduction is that position in which the inner border of the femur is placed tangentially to the outer ischial border. Too much flexion of the hip is inad-

visable since the femur obscures the ischium and ilium.

The forward tilting of the pelvis is recognized by the increased surface face of the ischial socket. The ilium is seen from the side rather than full face.

The obturator foramen is opened widely by apparent spread of its pincers. The ischiopubic interval is increased. The ischial and pubic parts of the socket are more easily seen and better outlined. The ischium is seen to have two borders medially, its most medial border bellying into the pelvis. The pubic part seems free of the ischial part.

On the opposite side, the pubic and ischial parts overlap; the pubis seems to overlie the ischium. The obturator foramen is not seen because of this overlapping and there is no ischiopubic interval. The ilium is seen full face.

In this position, the somewhat enlarged capital epiphysis occupies the inferior (ischial) and outer part of the socket, and overlies the metaphyseal plateau which, in turn, overlaps the ischium. There is a diminution in the distance which ordinarily separates the medial beak of the metaphyseal plateau from the ischium and an increase in the distance of the capital epiphysis from the acetabulum.

The line of the epiphysis is still downward and medial. The epiphysis is still intersected or falls within the prolongation of the line of the short iliac arm. The Perkins lines are of no value in this position of pelvic obliquity. When the lines are drawn perpendicular to the axis of tilt of the pelvis, it is seen that the capital epiphysis falls partly outside these lines. The determination of the roof angle is valueless in this position.

The femur is distorted and is shorter and wider. It seems spadelike. The greater trochanter is prominent. More of the trochanteric curve is seen and less of the plateau.

The particular value of roentgenography of the hip in this position is that it may give significant information of subluxation or dislocation of the hip. This position of the hip will certainly indicate improper position of the caput. Proximal push in the line of the adducted femur should push the head upwards if there is subluxation or dislocation.

ROENTGENOGRAPHY OF THE FETAL HIP

We have examined abdominal roentgenograms of 15 pregnant women. The indication (by others) for roentgenography was a determination of fetal position, and not the position of the hips. The majority were anteroposterior roentgenograms, but some were anteroposterior and lateral views of the abdomen. A few plates were satisfactory in indicating the position of the hips. The hips are not seen symmetrically since they may be in different planes. One hip may be in flexion and abduction, the other in flexion and adduction. The tibia and fibula may overlap the ilium and ischium. Foreshortening of the femur is seen when the hip is flexed. The knee is usually flexed. One side of the pelvis may be seen front face, the other from the side. Enough is seen to indicate the relation of the femur to the acetabulum, especially in the later months of pregnancy when bony development is greater. The capital epiphysis is of course not seen (Table II).

TABLE II

THE FETUS IN UTERO

(After Tchaperoff)

Appearance of Centers of Ossification

No center of ossification at the 7th week	
At 9 weeks	all cervical and first dorsal vertebrae are seen
	iliac wings
	femoral shaft
	tibia and fibula
At 21 to 25 weeks	os calcis
At 24 to 28 weeks	talus
At 35th week	lower femoral epiphysis
At 37th week	first coccygeal segment
At 39th week	proximal tibial epiphysis

It is obvious that fetal roentgenography may be more successful in the later months of pregnancy. A proper technique is needed—one in which the fetal skeleton is

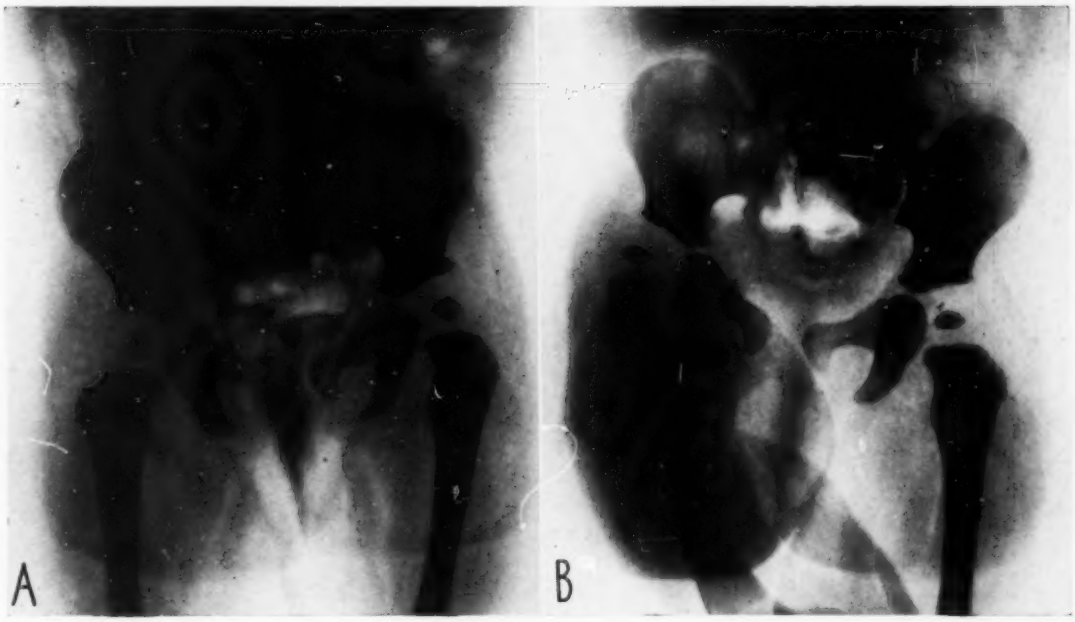

Fig. 9. *A*, roentgenogram of the hip joints of a female child seven months old. The left hip shows a marginal luxation. The head is not elevated but is placed farther away from the socket than is normal. If the Perkins lines are visualized on the illustration, it will be seen that the capital epiphysis is not in the inferomedial quadrant of the cross. While the epiphysis is intersected by the prolongation of the short iliac line, it rests more on the outside of this line than within it. There is a very slight distortion of Shenton's line. Boxing of the trochanters is indeterminate, although the lesser trochanter is questionably elevated. Clinical examination showed slight shortening of the left lower extremity and a disparity in the two gluteal creases. This elevation of the left gluteal crease is also seen in the roentgenogram. (This child is a patient of Dr. L. Saltzman and is presented with his permission.) *B*, flexion-adduction roentgenogram of the same child. The film is reversed. The marginal position of the capital epiphysis is more evident.

selectively picked out and which does not demonstrate the maternal skeleton clearly. Anteroposterior and lateral stereoscopic technique is probably necessary and is advised by Tchaperoff. The use of prostigmin before roentgenography dispels gas shadows. It gives increased intestinal action twenty to thirty minutes after the administration of the drug. It is possible that the drug may be harmful to the pregnant mother since, if it increases intestinal tonus, it may also increase uterine tonus, with possible premature expulsion of the fetus.

Tchaperoff points out that the fetus may not be seen on the film if it moves during roentgen exposure. Rarely, in stereoscopic roentgenograms, one film may show the fetus, the other not.

The value of fetal roentgenography is for the moment only of scientific interest and the method needs development. A mother having one child with congenital dislocation of the hips may be assured that the child in her womb is free of this developmental stigma, granting that our technique and knowledge of this procedure become adequate. We may become able to point out that such a deformity does exist *in utero*, and we may be able to do this theoretically even as early as the ninth week of fetal life. We shall, of course, be unable to influence the development and progress of such deformity.

Since this consideration is of more than theoretical interest, it necessarily concerns itself with the development of congenital dislocation of the hip. It is admitted by most observers that the dislocation is not created *de novo* by the trauma of birth,

although occasionally proponents of birth trauma, as W. Nathan, are found. The observations of Harrenstein indicate that such dislocation begins in the early embryologic period of life. The anlage of the hip joint is laid down in the fetus of 2 cm. length. This luxation or predisposition to it must be due to incomplete anlage of the hip joint, the actual dislocation taking place by developmental mechanical force, which is essentially the gradual extension of the flexed fetal spine. Harrenstein reports 5 cases of congenital dislocation of the hip in prematurely born infants, five to seven fetal months of age (25 to 39 cm. long). Four of these 5 cases were females. In 2 cases both hips were dislocated. He notes that in early fetal life—the fourth month—the female pelvis can be differentiated from the male, the opening of the acetabulum being more vertical and sagittal in the female. This may be a possible roentgenographic method of early sex determination.

THE ROENTGENOGRAPHIC DIAGNOSIS OF CONGENITAL DISLOCATION OF THE HIP IN THE FIRST YEAR OF LIFE

The attempt to diagnose this disability so early in life should be divided into two periods, that is, before and after the appearance of the capital epiphysis. It will be easy in the latter period, since the position of the epiphysis must be imagined before it has appeared.

The position of the epiphysis is away from the socket, carried upward by the high riding femur. The medial metaphyseal beak is at the level of the upper ischial socket and is farther away from the ischium. The epiphysis falls outside the short iliac line, and is not in the inferomedial quadrant of Perkins' lines. Horizontal boxing of the trochanters indicates the high position of the trochanters. Vertical boxing shows that the medial perpendicular line intersects the iliac wing and falls outside of the iliac roof. The lateral perpendicular line is at a much greater distance from the iliac wing and cannot intersect it. Shenton's line is distorted. The epiphysis may be smaller than normal, or its appearance delayed. The acetabular roof is indistinct and very sloping. The femur itself is unaltered, and there is no particular change in the femoral neck. After reduction and maintenance of reduction the iliac roof becomes more distinct and the roof angle more normal.

There is disparity in the gluteal and thigh creases in unilateral dislocation and one knee is higher than the other.

The coördination of clinical signs and roentgenographic findings should not make the diagnosis difficult. This is indicated by the report of Poli of Milan, who, in a series of 8,610 patients with 11,532 congenitally dislocated hips, pointed out that the dislocation was recognized at birth in 493 cases (6.31 per cent), and in the first year of life in 320 cases (4.06 per cent). The laity and the medical profession of North Italy have been taught to observe this deformity. Marx notes that the incidence of congenital dislocation of the hip was 1 per cent in normal births and 11 per cent in breech presentations in a group of 8,544 infants born in Kharkov in 1937. Spontaneous reduction in the first few days of life was seen in 47.4 per cent and in the later months of the first year of life in 17.5 per cent in a group of cases studied in a maternity institution.

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DIAGNOSTIC ERRORS IN ULCERATIVE LESIONS OF THE STOMACH AND DUODENUM

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THE roentgenologic diagnosis of gastrointestinal diseases has shown a steady gain in exactitude since 1898 when Cannon[6] first visualized the alimentary tract with the aid of contrast material. While, according to Berg,[3] a decade ago the roentgen examination of the gastrointestinal tract served only as a confirming factor of the clinical diagnosis established by careful examinations lasting for several days, at present it is carried out whenever a decision is necessary to clarify a given problem with rapidity.

The better knowledge of the normal and abnormal mucosal pattern of the alimentary tract based on the well known studies of Forssell,[7] Åkerlund,[1] and Berg[2] represents additional diagnostic refinement, while the various recently developed "spot film" devices furnish roentgenograms of almost any part of the gastrointestinal tract under the most favorable circumstances and under roentgenoscopic control.

Despite the accuracy of the method, roentgenologic errors are not infrequent, but are not usually published. Most of the erroneous diagnoses are based on either the technical difficulties inherent in the patient because of advanced illness or obesity (high stomach lying underneath the costal arch), or on the incorrect deductions from the roentgenoscopic or roentgenographic findings.

While years ago most of the mistakes were due to faulty technique, at present the errors are due mainly to the incorrect interpretation of the findings and not to the failure in discovering the lesion.

The purpose of this communication is to emphasize the pitfalls and difficulties in differential diagnosis of some of the ulcerative lesions of the stomach and duodenum.

ULCERATIVE LESIONS OF THE STOMACH

Aside from the very small lesions, the great majority of ulcerative lesions are readily detected on the roentgenologic examination. However, the differentiation as to whether they are benign or malignant is often difficult.

One of the most generally accepted diagnostic criteria in regard to the differentiation between benign and malignant ulceration based upon the location of the niche was brought forward by Sproull[15] in 1931. Reviewing the literature, in connection with one of his own observations, he stated that all niches found on the greater curvature of any part of the stomach should be considered malignant until proved otherwise, demonstrating his point with a case report. Although this conclusion is helpful in certain instances, the deductions based on the localization of the ulcer may lead to mistaken diagnoses.

Figure 1 (Case 1) shows a niche-like shadow, measuring 5 mm. in diameter, on the greater curvature of the prepyloric end of the stomach in a woman, aged sixty-three. The duodenal bulb was spastic. On account of the location of the niche on the greater curvature, the findings were interpreted as being most likely due to an early malignant lesion. At operation, however, the roentgenologic changes were found to be due to a small gallstone perforating into the stomach. The gallbladder was adherent to the pyloric end of the stomach and there was a fistulous tract between the two organs. In the fistulous tract was imbedded a small calcium carbonate gallstone which simulated the appearance of an ulcer niche on the greater curvature of the stomach.

Figure 2 (Case 11) shows a niche, 12 mm. in diameter, on the greater curvature of the prepyloric end of the stomach obtained in February, 1936. The gastric rugae appeared to radiate toward the niche and were definitely

widened throughout the entire preplyoric region (Fig. 3). A re-examination twenty-four hours later showed the findings to be unchanged. The patient, aged fifty-five, complained of epigastric pain of eight months' duration. Although the location of the niche and the short duration of the symptoms were both suggestive of a malignant ulcer, it was decided to place the patient on an ulcer diet before laparotomy was attempted. A re-examination three weeks later showed the niche to be smaller; therefore, it was decided to continue this form of therapy. Subsequent examinations showed the niche to have completely disappeared. Figure 4, taken in August, 1937, one and one-half years after the first examination,

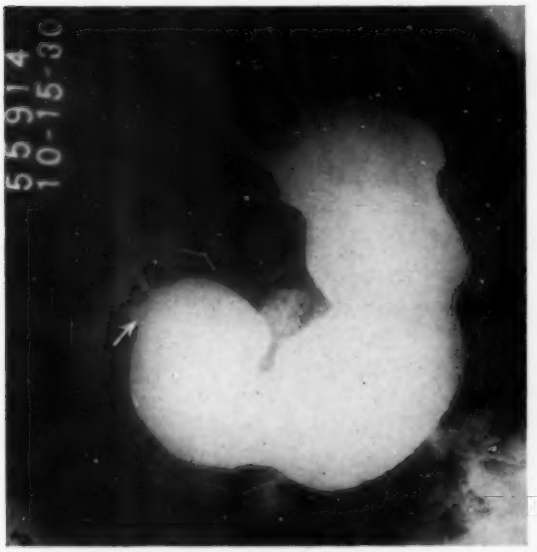

Fig. 1. Case I. Niche-like projection on the greater curvature of the prepyloric end, due to a gallstone perforating into the stomach.

showed the prepyloric deformity to be absent and, while the prepyloric rugae were still moderately widened, their arrangement appeared to be normal. The patient was free of symptoms, and continued to remain well to the present time, four years after the original examination. The negative findings during the long period of observation leave no doubt that the ulcer was benign in character despite its localization on the greater curvature.

But even if the niche is located on the lesser curvature, where benign ulcers are most common, the differentiation between a benign and a malignant process may occa-

Fig. 2. Case II. Niche measuring 12 mm. in diameter on the greater curvature of the prepyloric end of the stomach, originally thought to represent a malignant ulcer.

Fig. 3. Case II. The prepyloric rugae are widened and radiate into the ulcer crater which is surrounded by a defect in the gastric wall.

Fig. 4. Case II. Film taken one and one-half years after the original examination no longer shows the ulcer crater. Prepyloric rugae are parallel.

sionally be difficult or well nigh impossible. Kirklin,[11] in 1934, called attention to a very important sign, the so-called "meniscus" sign (crescentic crater with its concavity directed outward) (first described by Carman in 1921) to serve as an aid in the differential diagnosis between the two conditions. The barium filled crater is separated from the barium in the stomach by a clear zone which represents the approximated overhanging border of the ulcer.

Another diagnostic sign which is commonly utilized in differentiation is the size of the ulcer crater. Kirklin[12] stated that in every case when the ulcer niche measures over 2.5 cm. in diameter, a malignant process should be suspected. The differential diagnosis is made more difficult by the fact that they may occur in very young individuals also. King,[10] in 1933, collected 40 cases of gastric cancer during the first and second decades of life. Bruckner[5] in 1936 collected 4 more cases and added 1 of his own. The youngest patient suffering from cancer of the stomach in the group of King's cases was an infant whose illness began during the tenth day of life, death occurring during the fifth week.

Prepyloric lesions with or without niche formation may also cause difficulties in differential diagnosis. Singleton[14] states that "any prepyloric ulcer within 2.5 cm. of the sphincter should seriously be considered as a malignant ulcer." Haudek[9] states that the prepyloric region is the most frequent site of carcinomata, about 80 per cent of gastric cancers originating in this region. According to him, benign ulcers are infrequently found there, the proportion being one pyloric ulcer to ten ulcers in the pars media of the stomach.

Hampton[8] found that prepyloric ulcer and pyloric cancer occur in the proportion of 1:12, but this statement is not exact because not all his cases were proved pathologically.

That the meniscus sign may occur in benign lesions as well as in carcinoma is shown by the following case.

The patient, aged fifty-three (Case III), was admitted with a history of recurrent gastric discomfort of eight years' duration. The roentgen examination (Fig. 5) revealed an irregularly defined ulcerative lesion on the lesser curvature of the pars media which measured 2 cm. in length and 1.5 cm. in width. The crater showed the typical meniscus sign due to the overhanging edges of the ulceration. The wall of the entire lesser curvature, from a point about 4 cm. above the niche to the pylorus, was rigid and showed a shallow filling defect. A diagnosis of ulcerative carcinoma of the stomach was made. Twenty-four hours after the roentgenologic study, the patient developed signs of perforation. Immediate laparotomy was performed and a perforated ulcer was found on the lesser curvature. The ulcer was plicated, but the patient died twenty-four hours after the operation of generalized peritonitis. At autopsy the lesser curvature of the stomach was found to be very firm and adherent to the surrounding structures. In the region of the lesser curvature the stomach wall measured 2 cm. in thickness. On the lesser curvature of the pars media, extending to the anterior as well as the posterior wall, there was an ulcer, the long axis of which was vertical to the long axis of the stomach. Its edges were raised, purplish red and undermined. It measured 6 cm. horizontally and 2 cm. vertically. The histologic exami-

nation showed a chronic peptic ulcer with a chronic inflammatory process of the lesser curvature of the gastric wall, but no evidence of carcinoma.

Consequently, the lesion was a benign ulcer on the midportion of the lesser curvature and the inflammatory change in the surrounding lesser curvature wall produced not only an extensive defect, but a typical meniscus sign also, suggesting the roentgenologic appearance of a malignant lesion. Furthermore, the roentgen examination failed to determine the exact size of the ulcer. The ulcer appeared to be much smaller on the roentgenograms than it actually was, because of the superimposition of the parts situated on the anterior and posterior wall. This discrepancy between the size of the ulcer on the roentgenogram and the actual size is not uncommon.

That the meniscus sign may be absent in malignant lesions is demonstrated in Figure 6 (Case IV), which showed a concave indentation of the gastric wall in the midportion of the lesser curvature, the deformity being very similar but less extensive than in the previous case.

Fig. 5. Case III. Irregularly defined ulcer crater on the lesser curvature of the pars media surrounded by a shallow filling defect extending to the pylorus, due to a benign ulcer associated with chronic inflammatory change of the gastric wall.

Fig. 6. Case IV. Small ulcer niche of the pars media in a male aged twenty-seven with a shallow defect of the lesser curvature wall above and below the crater, which proved to be a carcinoma.

In the central part of the filling defect there was a conical, sharply defined niche without overhanging edges which measured about 8 mm. horizontally and 4 mm. vertically. This roentgenogram was of a twenty-seven year old male who on admission complained of repeated attacks of hematemesis associated with occasional severe pain for the previous one year and three months. The findings were thought to be due to a benign ulcer with mucosal or submucosal swelling or infiltration of the gastric wall around the ulcer niche.

The patient was placed on a gastric ulcer regimen, but pain and occasional hemorrhage continued, necessitating a laparotomy four months later. At operation a large tumor was found on the lesser curvature of the stomach, beneath the left lobe of the liver. The stomach was opened and the ulceration was seen to be in the center of a large, soft, friable tumor. The lesion was inoperable, and biopsy was taken which was reported to be carcinoma simplex.

In this case, a small lesser curvature ulcer niche in a twenty-seven year old individual was found to be due to a malignant lesion. It did not show overhanging edges, but was surrounded

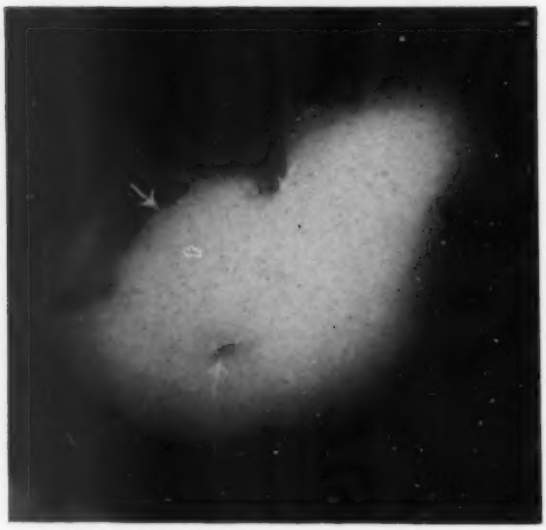

FIG. 7. Case v. Ulcer crater on the lesser curvature, measuring 9 cm. in diameter. At autopsy the ulceration was found to be benign.

by what was erroneously believed to be an inflammatory change of the neighboring gastric wall.

That a niche may attain a tremendous size without being malignant is well demonstrated in Figure 7 (Case v), obtained of a male, aged sixty-nine, who gave a history of gastric disturbance of four years' duration. The ulcer crater was on the lesser curvature of the stomach, showed overhanging edges, and measured about 9.5 cm. in diameter. The size of the crater suggested malignant ulceration.

At autopsy, twelve days after the roentgen study, the anterior and posterior wall of the stomach was found to be greatly increased in thickness and density. On opening the stomach an area of ulceration was found on the lesser curvature, measuring 9 cm. in diameter. The margin of the ulcer was undermined and raised, but grossly it was impossible to tell whether the ulcer was benign or malignant. Sections of the margin revealed it to be composed of white, homogeneous tissue, within which there was a poorly defined, gray, translucent granulation tissue. The base of the ulcer was adherent to the pancreas. Microscopic studies revealed a chronic peptic ulcer with necrotic margin without evidence of malignant changes.

Figure 8 (Case vi) demonstrates an extensive area of ulceration involving the entire circumference of the distal portion of the pars media and almost the entire prepyloric end, producing large filling defects. Emptying of the stomach was delayed and there was a 70 per cent gastric retention at six hours. The patient, a female, aged fifty-six, was admitted with a history of considerable epigastric pain of three months' duration associated with occasional hematemesis. The blood Wassermann and Kline exclusion tests were 4 plus. The diagnosis of a malignant lesion or syphilis of the stomach was suggested.

At a subsequent operation the distal half of the stomach was found to be indurated and a gastric resection was performed. On opening the specimen a large dumb-bell shaped area of mucosal ulceration was seen to encircle the stomach. The widest part of this ulceration measured 5 cm. in diameter. The lesion produced a partial constriction of the gastric lumen. Above it on either side there was intact mucosa which was brownish-pink and showed coarse rugae. At some points the ulceration completely replaced the wall and extended to the serosa.

The histologic examination showed evidence of a chronic gastric ulcer. Numerous sections were made of the area of ulceration and were carefully studied by several pathologists, including Dr. H. T. Karsner, but no changes

FIG. 8. Case vi. Extensive ulceration involving the entire circumference of the distal one-third of the stomach imitating the appearance of a malignant or syphilitic lesion. Histologic examination revealed chronic gastric ulcer.

could be found to suggest the presence of either a syphilitic or a malignant lesion.

This case demonstrates an extensive area of ulceration encircling the entire gastric wall and constricting the lumen, thereby producing extensive and irregular defects simulating the roentgenologic appearance of a new growth. Although the patient's serology was strongly positive for syphilis, there was no histologic evidence of syphilitic changes in the resected specimen and the etiologic factor could not be determined. The patient's symptoms disappeared after the operation.

Figure 9 (Case VII) shows a marked narrowing of the pyloric end of the stomach in a patient sixty-eight years of age who had a 4 plus Wassermann reaction. The narrowed portion measured 6 cm. in length and extended from the body of the stomach to the pylorus. Its contours were sharply defined and barium passed very slowly through this region. There was 60 per cent gastric retention at six hours.

Re-examination of the stomach five weeks later showed the lesion to be unchanged in appearance and surgical exploration was decided upon as the roentgenologic findings were interpreted as being due to either scirrhous carcinoma or a syphilitic lesion. At laparotomy a firm mass was found in the prepyloric and pyloric regions of the stomach. No evidence of metastases was found in the liver, omentum, or

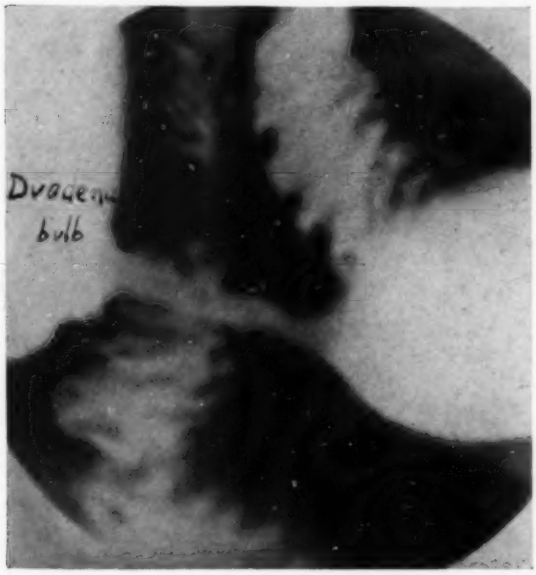

Fig. 9. Case VII. "Spot film" showing detail of the narrowed pyloric portion of stomach.

Fig. 10. Case VII. Photograph of resected portion of stomach showing shallow irregular ulcer in pyloric region.

serosal surfaces. The distal half of the stomach was resected.

Pathologic examination of the gross specimen showed an irregular, shallow ulcer measuring 3 cm. in its widest diameter in the prepyloric and pyloric regions (Fig. 10). Histologic examination of the resected specimen showed a chronic gastric ulcer. The wall of the resected portion of the stomach was greatly thickened due to the presence of a very severe edema. This accounted for the marked narrowing of the lumen.

Consequently a benign prepyloric ulcer produced a narrowing in the entire pyloric portion of the stomach which was seen on several examinations during an interval of five weeks. There was no demonstrable ulcer niche and the appearance suggested either a scirrhous carcinoma or, in view of the clinical findings (4 plus Wassermann), a syphilitic lesion.

Figure 11 (Case VIII) shows an ulcerative area measuring about 3 cm. in length and 1 cm. in width, high on the lesser curvature of the stomach a few centimeters below the cardioesophageal junction. It was surrounded by a semicircular filling defect above and below. The changes were thought to be due to a malignant ulcerative tumor. The patient complained of epigastric distress of seven years' duration without nausea and vomiting. Exploration revealed a firm mass high on the lesser curvature of the stomach, adherent to the liver. The lesser curvature was opened, a finger was inserted, and numerous fungating masses were felt inside,

Fig. 11. Case VIII. Ulcerative area high on the lesser curvature surrounded by filling defects suggesting an ulcerative carcinoma.

thought by the operator to be cancer. Biopsy was taken from the margin of the deformity and was reported to be chronic inflammatory tissue.

One year and seven months later the patient was re-admitted to the hospital. Gastrointestinal study (Fig. 12) revealed the proximal part of the cardiac end to be free of the previously described defect. Just below the cardiac end, mainly on the greater curvature, there was an extensive filling defect with an area of ulceration on the lesser curvature. Although the discrepancy between the findings at the two examinations (the disappearance of the defects in the region of the cardio-esophageal junction) could not be explained satisfactorily, it was still believed that the changes were due to a malignant lesion.

The second exploration revealed a large penetrating ulcer on the posterior wall of the stomach, the base of which apparently perforated into the pancreas. The ulcerative areas extending into the pancreas measured 5×3 cm. Despite the great difficulties caused by the perigastric adhesions, a sleeve resection was carried out, the proximal end of the stomach being resected 1 inch below the esophagus. The patient died seventy-two hours after the operation.

The diagnosis of the surgical specimen was chronic peptic ulcer (perforating into the pancreas) and chronic hypertrophic gastritis. Subsequent autopsy failed to reveal any evidence of a malignant process.

Apparently the ulcer of the cardiac end of the stomach had perforated into the tail of the pancreas sometime before the first examination and set up an infection in it as well as in the neighboring tissues. The perigastric inflammatory changes led to the production of filling defects, which in turn led to the erroneous diagnosis of carcinoma of the stomach. The variation in the location of the filling defects was difficult to explain, but in retrospect, we realize that they were due to a change in the location of the inflammatory process in the pancreas.

Figure 13 (Case IX) shows a rather sharply defined area of narrowing of the prepyloric end of the stomach involving an area measuring about 3 cm. in length. Proximal to it there is a spherical niche on the lesser curvature extending to the posterior wall and measuring about 3 cm. in diameter. There was about 70 per cent gastric retention at six hours and the diagnosis of ulcerative carcinoma was made. The patient was a female, aged forty-six, who was admitted

Fig. 12. Case VIII. Same case one and one-half years later. Niche still persists, but the distribution and size of surrounding defects changed. At autopsy a chronic non-carcinomatous ulcer perforating into the tail of the pancreas was found.

with a history of gastric complaints of only three months' duration with occasional vomiting two hours after meals.

Laparotomy revealed an indurated mass in the pyloric end of the stomach. Its posterior part was densely adherent to the pancreas. The gross appearance was that of a malignant lesion. Gastric resection was carried out and on section two ulcers were found in the pyloric end. The mucosa throughout the entire pyloric portion was markedly thickened and firm, but elastic. The microscopic diagnosis of chronic peptic ulcer and hypertrophic prepyloric gastritis was made.

In this case we were dealing with a prepyloric lesion with marked constriction of the distal end of the stomach and an area of ulceration, the ulcer craters measuring 3 cm. in diameter. The roentgenologic appearance and the location of the lesion were very suggestive of a malignant lesion. The short duration of symptoms appeared to be an additional confirming factor. This impression was confirmed at operation, the gross appearance of the lesion being that of carcinoma. However, subsequent pathologic study showed the lesion to be benign, the pyloric mass having been due to gastritis with scar tissue formation. Instead of one ulcerative area shown on roentgen examination, two individual ulcers were found, the aggregate circumference of which was larger than the roentgenogram indicated. Consequently, in evaluating the findings, two errors were made in the conclusion.

Fig. 13. Case IX. Ulcer niche on the lesser curvature with marked narrowing of the prepyloric end suggesting ulcerative cancer. Microscopic examination of specimen showed chronic peptic ulcer and hypertrophic pyloric gastritis.

ULCERATIVE LESIONS OF THE DUODENUM

The majority of the ulcer craters in the duodenal bulb are small. Most of them vary between 4 to 10 mm. in diameter, and craters measuring over 1 cm. in diameter are rather rare. Even rarer are craters which involve the entire duodenal bulb or the greatest part of it, and measure between 2 to 4 cm. in diameter. These are the so-called giant ulcers. Roentgenologists are not familiar with their appearance because of their rarity. We have found only 7 giant duodenal ulcers reported in the roent gen literature up to the present time, all of them in foreign publications. Brdiczka[4] in 1931 reported the first 3 cases and Knutsson[13] in 1934 added 4 more cases. The important feature in these giant ulcers is that they can be easily overlooked because the crater simulates the appearance of either a normal or slightly abnormal bulb. Occasionally the appearance of a giant ulcer niche simulates a diverticulum. The diagnosis in Brdiczka's first 2 cases was missed and only the third case was diagnosed correctly, based on the experience gained from the previous 2 cases.

Of Knutsson's 4 cases only 2 were correctly diagnosed. One of his cases, as proved by histologic examination, was a carcinomatous ulcer. According to Brdiczka, on roentgenologic examination the entire ulcer crater fills suddenly with the contrast material, the contours of the crater are smooth and its wall possesses a rigid, unchangeable form. The mucosal pattern as well as the radiating rugae seen in duodenal ulcers is lacking, because at least an entire wall of the bulb is involved by the crater and the nonulcerated part of the wall becomes stretched. Distal to the niche the pars superior of the duodenum is com-

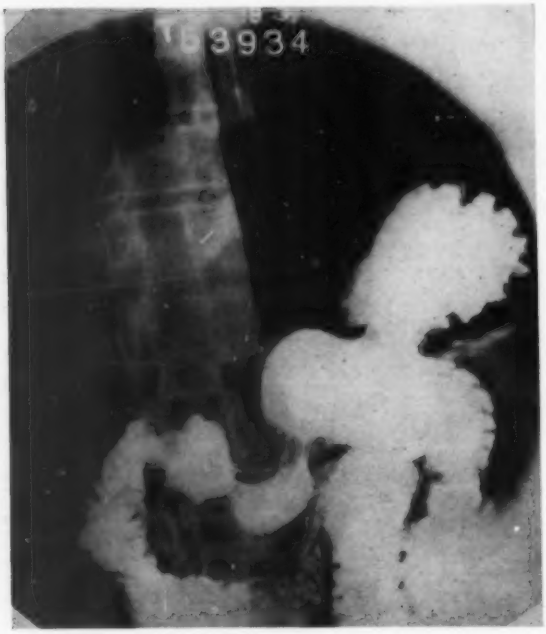

FIG. 14. Case x. Giant ulcer niche measuring 2.5×2 cm. simulating a globular and slightly irregular duodenal bulb.

monly narrowed either by spastic or organic constriction often leading to a roentgen diagnosis of stenosis of the pars superior and to the incorrect assumption that the large pool of contrast material lies in the intact or slightly deformed bulb.

In Brdiczka's first 2 cases, the diagnosis of stenosis of the midportion of the pars superior was made, while in Knutsson's 2 cases, which were incorrectly diagnosed, the examiner did not realize that what appeared to be a deformed bulb was actually a giant ulcer crater.

We have encountered 2 cases of giant ulcers of the duodenal bulb. In the first case the diagnosis was missed, while in the second case the correct diagnosis was established.

Figure 14 (Case x) was obtained of a male, aged fifty-nine, who was admitted complaining of epigastric discomfort for the past five years. The epigastric pain became more marked during the ten days before admission and was exaggerated by eating and exercise. Roentgen study revealed thickened gastric rugae and marked gastric hyperperistalsis. The pylorus was wide. The contour of the duodenal bulb was irregular, but no niche could be seen in it. Just distal to the irregular bulb the duodenum showed an area of narrowing. The rugae throughout the second portion of the duodenum were thickened. The provisional diagnosis of a pathologic process of the duodenum was made and a re-examination was requested.

However, twenty-four hours after the examination, the patient had several hemorrhages and died a few days later. At autopsy an ulcer measuring 2.5×2 cm. in diameter was found on the posterior aspect of the duodenum. At the inferior margin the gastroduodenal artery passed through the wall of the ulcer and had been completely eroded, so that its open ends projected into the ulcer. At the superior aspect of the ulcer there was a walled off perforation.

The ulcer niche was well visualized on the films and it was due only to the lack of experience with this type of case that it was considered to represent a slightly deformed duodenum. Just beyond the ulcer crater, a narrowing of the bulb could be seen, which was similar to what Brdiczka and Knutsson found in their cases. Furthermore, the pyloric recess in the basal portion of the bulb was obliterated and the structure was more spherical than is usually observed in a normal duodenal bulb.

The second patient suffering from a giant duodenal ulcer was a male, aged forty, who had recurrent attacks of severe epigastric pain related to meals for the past two years, associated with occasional hematemesis and tarry stools (Case xi). A gastrointestinal study revealed the presence of chronic gastritis with gastric hyperperistalsis. The duodenal bulb was large and along the lesser curvature of its distal end there was a circular structure, which measured 3.5 cm. in diameter. It was smooth in outline and its appearance suggested a diverticulum at first. However, the structure did not empty on palpation, its walls were rigid, and it remained filled throughout the entire examination (Fig. 15). The structure was found to be tender on palpation and was fixed. Occasionally, when the duodenal bulb remained free of contrast material, the entire structure became well visualized (Fig. 16). There was no evidence of a stem-like connection between the bulb and the circular structure as seen in diverticula, but there was a constant narrowing of the pars superior just distal to the structure. An examination at six hours showed no gastric retention except in the circular area in the duodenum which re-

mained filled with barium for twenty-four hours.

Laparotomy on December 20, 1935, revealed an inflammatory mass contiguous with the upper border of the duodenum, 5 cm. distal to the pyloric vein. This mass involved the retroperitoneal tissue and measured 8×6 cm. in size. It was quite fixed and adherent to the duodenum. The gallbladder was adherent to the anterior surface of the duodenum. It was impossible to dissect the lesion from the pancreas and gallbladder, and therefore a partial gastrectomy and Polya anastomosis was carried out. The patient has remained free of symptoms to date, almost three years after the operation.

This case was interesting from two standpoints. First, on account of the unusual size of the ulcer crater and, secondly, because of its diverticulum-like appearance. However, despite its smooth contour and spherical form, the structure did not show a connecting stem with the remaining part of the bulb. It was tender on palpation and was constantly filled with contrast material. In the case of a duodenal diverticulum, the structure shows peristaltic contractions and serial films usually show a more or less marked degree of filling on various exposures, some of them demonstrating the normal duodenal mucosal pattern in the diverticulum. In this case, despite the fact that the remaining portion of the duodenum occasionally emptied itself of the contrast material, the ulcer crater did not show any evidence of emptying or contraction in size.

Fig. 15. Case xi. Large duodenal bulb with a fixed, diverticulum-like, barium containing structure on its lesser curvature. Note narrowing of the bulb distal to structure.

Fig. 16. Case xi. The circular structure is better visualized when the duodenal bulb is free of barium. It represents a giant ulcer crater.

CONCLUSIONS

1. There are many accepted roentgenologic signs which are utilized in the differentiation between malignant and benign lesions of the stomach. They are based on the morphologic appearance, the size and location of the crater, and the appearance of the adjacent gastric wall. However, none of the signs is always reliable. The exceptions to the rule are not uncommon and the utmost care should be used in evaluating a given finding.

2. It is generally accepted that ulcers on the greater curvature of the stomach are quite commonly malignant. Nonmalignant lesions in this location, however, may

occur. The finding of an ulcer crater on the greater curvature does not justify the unequivocal diagnosis of an ulcerative carcinoma.

3. A benign prepyloric ulcer may lead to a considerable amount of inflammatory tissue formation or swelling of the mucosa and thereby may imitate the roentgenologic appearance of a malignant process or a syphilitic lesion. The roentgenologic study accurately localizes the prepyloric lesion but so far no signs are available by which its benign or malignant nature can be differentiated.

4. The meniscus sign may occur in benign as well as in malignant lesions.

5. The size of the gastric ulcer is unreliable as far as the differentiation between benign ulcers and ulcerative carcinomas is concerned. Ulcerative carcinomas may be small, while giant craters may represent benign lesions. The accurate size of the ulcer crater cannot always be determined by the roentgen examination.

6. Roentgenologic examination depicts morphologic and not microscopic changes; frequently even the gross examination of the pathologic specimen may not disclose the true nature of the lesion and the differential diagnosis is made microscopically.

7. Giant ulcer craters may occur in the duodenal bulb and their appearance may imitate a normal or a slightly deformed bulb.

8. Giant ulcers of the bulb may simulate a diverticulum, but the stem-like connection with the lumen of the bulb is missing, the wall is rigid, and there is usually an area of constriction distal to it.

9. The knowledge of the existence of giant duodenal ulcer should lead to the correct diagnosis in an increasing number of cases.

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ROENTGENOLOGICAL STUDY OF GASTRIC TUBERCULOSIS*

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THE subject of tuberculosis of the stomach constitutes one of the great problems of gastric pathology. Clinically, this localization of tuberculosis is generally considered an extreme rarity, without appreciable practical significance. Accordingly, the literature on tuberculosis of the stomach contains mainly case reports; the few monographic presentations of the subject reflect the confusing views expressed in various papers.

In contradistinction to the high frequency of intestinal ulcerations in the terminal stage of pulmonary tuberculosis, the occurrence of similar manifestations in the stomach is extremely rare. Whereas, according to Kaufmann, intestinal involvement is encountered in not less than 90 per cent of the tuberculous cases, and therefore presents a practically regular finding, the generally conceded incidence of gastric tuberculosis varies between 0.4 and 2.1 per cent.

As compared with the remaining segments of the digestive tract, and especially with those which are sites of predilection of the ulcerative visceral tuberculosis, e.g., the lower ileum and cecum, the stomach shows an obviously high resistance to this infection.

This disproportion between exposure and infection gave rise to many theories attempting to explain which anatomic and physiological characteristics cause the marked immunity of the stomach to the tuberculous infection. Virchow, Klebs, Rokitansky, Curschmann and other authors were of the opinion that the sparsity of the lymphatic supply of the gastric wall was responsible for it. They based their conception on the fact, that the ileum, e.g., where tuberculous lesions are most frequently encountered, contains a well developed lymphatic system, and the gastric tuberculosis is in the majority of cases localized in the region of the pylorus, where lymph nodes are relatively numerous. Wilms, Blass, Hanou, Stolzmann, and Weinberg presented a different view and did not attach any significance to the lymphatic system in the origin of the tuberculous infection of the stomach. Wilms observed, at least in cases of hematogenous miliary tuberculosis, a large number of tuberculous nodules in all layers of the stomach, without any evidence of affection of the lymphatic system. Marfan, Ricard and Chevrier, Blass, and Orth were of the opinion that small defects of the gastric mucosa present an important factor in the establishment of the infection in the stomach. Orth arrived at this conclusion from experiments on animals.

Much has been written about the protective action of the hydrochloric acid. Almost all authors, however, now seem to think that the gastric juice is unable to exert an inhibitive influence on the growth of the tubercle bacillus in the stomach (Baumgarten). This view is confirmed by the fact that so few patients with pulmonary tuberculosis develop a gastric tuberculosis, although many investigators (Briger, Zimmermann) found a hypoacidity on examination of gastric contents.

Another factor preventing an infection of the stomach was seen in the physiological motility of this organ. It was contrasted with the habitual stasis of the intestinal contents within the cecum, which really presents a site of predilection of tuberculous inoculation. It seems, however, that this factor was overestimated. The normal emptying of the small intestine is consider-

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ably faster than that of the stomach, and yet there is no conclusive evidence of any protective mechanism in this respect.

PATHOLOGY

Gastric tuberculosis may present various pathologic forms, which have been classified into several types:

(1) Dissemination of miliary tubercles.
(2) Larger tuberculous foci.
(3) Tuberculous ulcer.
(4) Circumscribed tumefacient, hypertrophic tuberculosis.

(1) Miliary tuberculosis of the stomach is usually a manifestation of a generalized miliary tuberculosis. Miliary tubercles are found in the gastric mucosa, and according to Simmonds may also be encountered in other layers of the gastric wall (submucosa, muscularis).

(2) *Larger Tuberculous Foci.* In antithesis to the miliary tubercles, they present a lesion noticeable on macroscopic examination. Dewey found small nodules on the anterior and posterior wall near the lesser curvature (2–4 mm. high, 1 mm. long), which showed a definite relation with the lymphatics, and considered these changes as a tuberculous lymphangitis.

(3) *Tuberculous Ulcer.* An ulcer presents the most frequent form of gastric tuberculosis. An ulcer may occur as a single lesion or numerous ulcerations of various sizes. The multiple ulcerations are found more frequently than a single ulcer. The ulcers are usually round or oval, rarely annular; the ulcer extends usually into the muscularis mucosae and submucosa. It may, however, extend into the muscularis, and even the serosa, which forms then the only protective layer (Ricard and Chevrier, Leriche and Mouriquand, Fischer and Defoy). The microscopic appearance of a tuberculous ulcer is, as a rule, typical and characteristic. Its edges are elevated, rampart-like, irregular, undermined, frequently reddened, rarely hemorrhagic. The base of the ulcer is partly smooth, partly granular, or nodular, prominent, yellowish, filled occasionally with necrotic caseous material.

Most authors agree that the pyloric end of the stomach is a site of predilection of the tuberculous ulcerations, especially of a single ulcer. According to Arloiny, Ricard and Chevrier, and others, this form of tuberculosis affects the greater curvature less frequently.

(4) *Hypertrophic Tuberculosis.* This form of gastric tuberculosis develops primarily in the submucosa, and leads to a thickening of the gastric wall, producing usually an annular constriction of the lumen. In these cases, the pyloric end of the stomach is affected almost exclusively. Large tumors are formed, obstructing the pylorus. Clinically they are looked upon as gastric carcinomas. (In their similarity and in the fact that a well circumscribed, hypertrophic tuberculosis can be eradicated by gastric resection lies the great importance of an early recognition of this form, which has been frequently called "surgical tuberculosis of the stomach.")

Hypertrophic tuberculosis presents a hard, annular, or cylindric tumor; it may vary in size from that of a walnut to the size of a fist; it may move on palpation or present a well fixed mass (Melchior, Konjetzny, Beresnegorski, Pfanner).

As a rule, this form of tuberculosis is associated with a tuberculosis of the regional lymph nodes and frequently involves the duodenum (Allessandri, Clairmont, Gorodinski, Gourand, Ruge). In a few cases the greater part of the tumor was located in the duodenum, and the pylorus was involved secondarily (Durant, Patella, Pfanner). Stenosis of the pylorus may in those cases assume a very marked degree. The mucosa is rarely free from ulcerations. Usually small or fairly large ulcerations can be found in a prominent or atrophic mucosa. The most marked changes affect the submucosa, which is considerably thickened. The specific granulations extend in some places into the mucosa. Through caseous necrosis of this tissue, fistulous tracts between the stomach and duodenum may develop underneath the mucosa.

As a rule, the regional lymph nodes are

also involved in the presence of gastric tuberculosis. Frequently the involved lymph nodes dominate the picture; their swelling may produce large tumors (Momisett, Mouriquand). Caseous lymph nodes may communicate directly with the tuberculous lesion within the stomach (Rokitansky, Chiari, Kundrat, and others). However, there have been cases described in which there was no specific involvement of the regional lymph nodes, in spite of extensive gastric tuberculosis.

MODE OF INFECTION

Tuberculosis of the stomach may result from several modes of infection:

(1) Direct infection.
(2) Through the blood stream.
(3) Through the lymphatic system.
(4) From the serosa.

The hematogenous infection is caused by a bacillary embolus, as is the case in miliary tuberculosis.

Since the stream of the lymph is directed from the mucosa toward the serosa, an infection through the lymphatic system can occur only by means of a retrograde invasion, usually from infected perigastric lymph nodes. The possibility of a retrograde infection is facilitated by the blocking of the lymphatic ducts, resulting from adenitis and perigastritis.

From the serosa, the infection may occur either by continuity (rarely) or by contiguity (from lymph nodes, spleen, gallbladder).

In the literature the distinction is frequently made between primary and secondary gastric tuberculosis. This distinction does not seem to be entirely justified. If one understands by a primary tuberculosis, the primary localization of the infection within the gastric mucosa, then this classification is useless and incorrect, because there is not a single observation recorded in which the tuberculous lesion of the stomach has been proved to be primary, *sensu strictori*, according to Ranke. Such a proof cannot be offered even by careful postmortem examinations. If, however, those cases are considered as being primary tuberculosis, in which the clinical symptoms and the roentgenological findings indicate a gastric pathology, and other symptoms of a tuberculous infection are subordinate, then this classification may be of practical value. Desirable information could be obtained, especially in regard to the operability of such cases.

The fact that gastric tuberculosis has been found on postmortem examinations only as a partial manifestation of a more or less generalized tuberculosis can be readily understood, since these autopsies have been performed on tuberculous patients. It should be kept in mind that clinical and especially surgical observations are very much in favor of an isolated gastric tuberculosis.

SYMPTOMATOLOGY AND CLINICAL DIAGNOSIS

As stated previously tuberculosis of the stomach affects the pyloric end of the stomach. The clinical symptoms are therefore primarily those of a progressing gastric obstruction. The gastric chemistry is extremely variable. There are all transitions from marked hyperchlorhydria to complete achlorhydria. Hyperacidity is, however, less frequently encountered. In the majority of cases, a hypochlorhydria which may progress to a complete achlorhydria was observed.

A correct diagnosis can be expected only in some cases of "surgical gastric tuberculosis." These are cases with a "pyloric tumor" in young individuals, who are less apt to have a carcinoma. If the palpable tumor is smooth, shows no nodules, no gastric achylia, and no definite history of a gastric or duodenal ulcer, then these cases should be suspected of gastric tuberculosis, even though there are no other suggestive symptoms of this infection. The same condition should be thought of in an individual suspected of tuberculosis, who presents signs of a pyloric obstruction without a history of a chronic peptic ulcer.

The prognosis in cases of gastric tuber-

culosis depends on many factors. In spite of a relative benignity of gastric tuberculosis, it may be considered as a non-malignant lesion only temporarily. The prognosis is favorable only in its initial stage, and becomes serious as soon as a developing pyloric obstruction tends to decrease the general resistance with impaired nutrition.

Immediate complications of gastric tuberculosis are rare, with the exception of the above mentioned pyloric obstruction. Bleeding is especially rare. Perforation of a tuberculous ulcer was observed only in a very few cases; however, perforation into the pancreas has been described as occurring rather frequently. Other complications described were gastrocolic fistula and perforative peritonitis.

ROENTGENOLOGICAL CONSIDERATION

On roentgenological examination as great a difficulty is encountered as in clinical recognition of an isolated gastric tuberculosis. The roentgenological signs observed by the authors are insufficiently characteristic to be of pathognomonic value. Most papers concerning this subject are retrospective reviews of cases, which could not be recognized prior to surgical intervention. Pop and Hanganutin, who observed 4 cases of hypertrophic tuberculosis of the stomach, saw in the contour of the affected pyloric part of the stomach the most characteristic features, which could be utilized in differential diagnosis between gastric carcinoma and tuberculosis. Whereas, in carcinoma, the stomach shows irregular defects, producing an irregular ragged contour of the narrowed "amputated pylorus," in case of tuberculosis with pyloric stenosis, the borders of the tumor show straight lines; the "pyloric amputation" is linear.

Renander, in reviewing his series of cases, stressed the rather round contour of the shallow mucosa tumors, which should allow a differentiation from carcinomatous infiltrations with their rather sharply cut borders, but of course these signs are not sufficiently significant to be reliable.

Authors have stressed the lack of characteristic roentgenological manifestations of gastric tuberculosis, and arrived at the conclusion that the correct diagnosis depends on clinical observations and surgical exploration.

Our series includes 2 cases, in which the correct diagnosis was made from the pathological specimen, secured at the surgical intervention; and one case in which no anatomical confirmation was obtained.

The roentgenological diagnosis in one of the cases operated upon was that of a duodenal ulcer (Case 1), and in the other case roentgenoscopy and roentgenograms suggested a lymphoblastoma, or an inflammatory granulomatous process (Case II). In retrospect, we note on the films certain features, which, when carefully considered, may supplement the rather meager roentgenological symptomatology of gastric tuberculosis, and contribute to a foundation of its diagnosis on a firmer basis.

We shall now discuss these changes and give the case histories later:

The first case showed a normal stomach. The duodenal cap presented a peculiar deformity, which did not correspond with the type of lesion usually encountered in duodenal ulcers, and which may now be evaluated more correctly. The base of the duodenum was apparently normal, the pylorus was not excentric. From the upper border of the duodenal cap the barium filled a fairly long and narrow channel, which ended blindly. Below this channel there was another curved tract, through which the barium emptied into the descending portion of the duodenum. The descending portion of the duodenum showed a normal mucosal pattern, but its lumen seemed somewhat compressed along its medial contour just below the duodenal cap. There was considerable gastric retention at five hours.

This deformity of the duodenum was due to pathological changes which were partly intrinsic, and partly due to enlarged tuberculous perigastric and periduodenal lymph nodes compressing the duodenum. The

pouch was most likely a superficial sinus tract in the submucosa which communicated with the lumen of the stomach.

The second case seems to be more significant, and offers more diagnostic criteria, which may facilitate the roentgenological diagnosis of gastric tuberculosis. The lesion in this case involved the antrum and duodenum. On compression, the antrum showed numerous central and marginal defects. The marginal defects were located predominantly at the site of the greater curvature, and, on close observation, showed rather sharply defined semicircular borders with small extensions into the deeper layers of the gastric wall. Mucosal folds could be demonstrated within the central defects. The gastric mucosa was exaggerated, thickened, and in some places showed a stellate arrangement with a denser center, resembling a niche with convergent mucosal folds. The gastric peristalsis was considerably impaired, but on careful observation, an expansion of the gastric lumen was noted. On palpation a small mass at the site of the involved area could be felt. There was some tenderness. The mass was fairly movable. Barium emptied through the deformed pylorus into the duodenum, which also showed marked roentgenological changes. The duodenal cap was deformed. The descending portion of the duodenum was narrowed, spastic and irritable. The mucosa pattern was distorted. There was a fairly large ulcer niche at the mid-portion of the descending duodenal loop, below which the duodenum showed even more marked changes. The lumen of the duodenum was moderately dilated, mucosal folds were considerably thickened, and there were numerous filling defects, similar to those observed within the stomach. On the basis of these findings, we thought of a lesion which is rather systemic, and does not affect only one segment of the gastrointestinal tract. Lymphoblastoma seemed the nearest possibility. A rather diffuse granulomatous inflammatory process of undetermined origin was another possibility.

The third case also showed changes affecting the antrum and the duodenum. The pyloric end of the antrum was considerably narrowed. The gastric mucosa within the involved segment was thickened, irregular, and on compression showed some retention of barium. The antrum, though narrowed, dilated slightly with the advancing peristaltic wave. The duodenal cap showed a slight irregularity of the contour of its base.

In the final analysis of the roentgenological manifestations observed in our cases, we are impressed by the variety of symptoms found in the roentgenological morphology and physiology of the stomach and duodenum, all of which must be carefully evaluated, if an error of confusing an inflammatory process with a neoplastic disease is to be avoided.

These were the roentgenological changes noted in our cases:

(1) Location of the lesion: The pathological process was confined in all cases to the pyloric end of the stomach and duodenum.

(2) (a) Defects: The narrowed antrum showed central and marginal defects.

(b) The marginal defects were round, sharply defined, and were caused by enlarged extrinsic lymph nodes as demonstrated on the resected specimen.

(3) Mucosa: The central defects showed partly preserved mucosa. The gastric mucosa was thickened; on compression a convergence of the mucosa toward a superficial ulcer niche could be demonstrated in some parts of the stomach.

(4) Ulcerations: A retention of barium in several small ulcerations was noted.

(5) Peristalsis: Peristaltic waves were present in all cases. The affected antrum showed the wall to be flexible, indicating that the lesion did not affect the muscular layer of the stomach. This was at variance with a gastric carcinoma, which infiltrating the walls of the stomach, interferes rather early with a normal peristalsis.

(6) Duodenum: Similar roentgenological features to those encountered within the antrum were demonstrable within the duo-

denum. Filling defects could be demonstrated; the duodenal mucosa was thickened; ulcers, single or multiple, were observed. The lumen of the duodenum may be narrowed, because of infiltration of the wall, pressure by enlarged periduodenal lymph nodes, and spasm, which is occasionally very pronounced.

(7) The usually palpable mass is smooth, somewhat tender on palpation, and may be movable.

According to these observations, tuberculosis, especially the hypertrophic form, shows certain characteristics of a new growth on the one hand, and on the other, signs of a benign lesion can be demonstrated.

The narrowing of the antrum, the multiple defects, and a palpable mass, are the usual signs of carcinoma.

The preserved gastric mucosa, and relative lack of interference with the peristalsis, are not compatible with an advanced carcinoma, which the extensive pathological changes would indicate; nor is this assumption favored by simultaneous involvement of the duodenum in these cases.

It is interesting to note the frequency of duodenal involvement in cases of gastric tuberculosis. Goosmann (cited after E. Rolpke) found in 5,900 postmortems (including 2,360 cases of tuberculosis) tuberculous changes in 18 cases. The investigations of Ricard and Chevrier revealed that in 107 cases in which there was a tuberculous involvement of the stomach, the duodenum was affected in only 10 cases. Of 16 cases of pyloric tuberculosis, the duodenum was involved in 9 cases.

Stenosing tuberculous ulcers of the duodenum are rare. Wieting found, among 236 cases of tuberculous intestinal obstructions, only one case in which the duodenum was affected.

These statistics demonstrate the rarity of gastric tuberculosis in patients with a tuberculous infection of other organs. But it is rather remarkable that the incidence of duodenal involvement is high in cases of apparently isolated gastric tuberculosis.

We feel, therefore, that in cases, as the one previously described, tuberculosis should be considered, and an exploratory surgical intervention advised. This seems to be warranted by the fact, that these cases in which there is no other manifestation of a tuberculous infection can be cured by gastric resection.

REPORT OF CASES

Case 1. O. M., white male, aged fifty, was admitted to the University Hospital in July, 1937. Six years prior to admission patient complained of pain in epigastrium, indigestion, occasional vomiting, constipation and tarry stools. At that time patient lost some weight. Following conservative treatment patient improved after two to three weeks.

Similar attacks of epigastric pain occurred from time to time; the last one coming on three weeks preceding his entry to the hospital. Since then patient lost 20 pounds in weight, complained of intermittent pain in epigastrium, indigestion, vomiting, and tarry stools.

Gastric analysis showed free HCl of 93, total acidity 97. No other pathological findings were recorded regarding the gastric analysis. Red

Fig. 1. Case 1. Deformed duodenal cap; long sinus tract along its superior border.

blood count 3,800,000, white blood count 8,300 and hemoglobin 80 per cent.

Roentgenographic examination showed the previously discussed deformity of the duodenal cap, and a diagnosis of an ulcer was made.

At operation a hard nodular mass involving the first portion of the duodenum and pylorus, with multiple small, hard nodules over the adjacent liver surface and peritoneum, was found.

A posterior gastrojejunostomy was performed and a biopsy was secured from the exogastric tumor mass. The microscopic examination showed in all sections granulation and fibrous tissue, in which some areas were intensely infiltrated with leukocytes, many of which were eosinophilic. Many of the blood vessels were engorged. The outer border showed a predominance of connective tissue. There were many large encapsulated giant cells centrally localized and others scattered throughout the section. Some of the giant cells showed central necrosis, others appeared degenerated. The pathological diagnosis was that of an acute tuberculous inflammation.

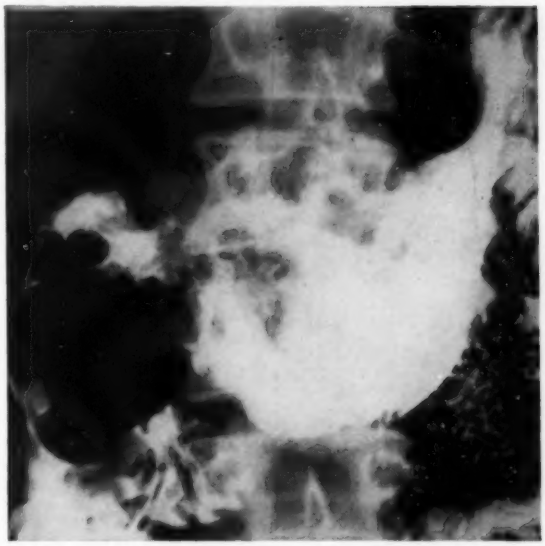

Fig. 2. Case II. Marginal, sharply defined defects within the antrum; narrow second portion of the duodenum; large ulcer niche at its medial contour.

Case II. H. P., white female, aged forty, was seen in the Out-Patient Department of the University Hospital, complaining of general weakness, vague abdominal pain, which seemed to increase in intensity several hours after

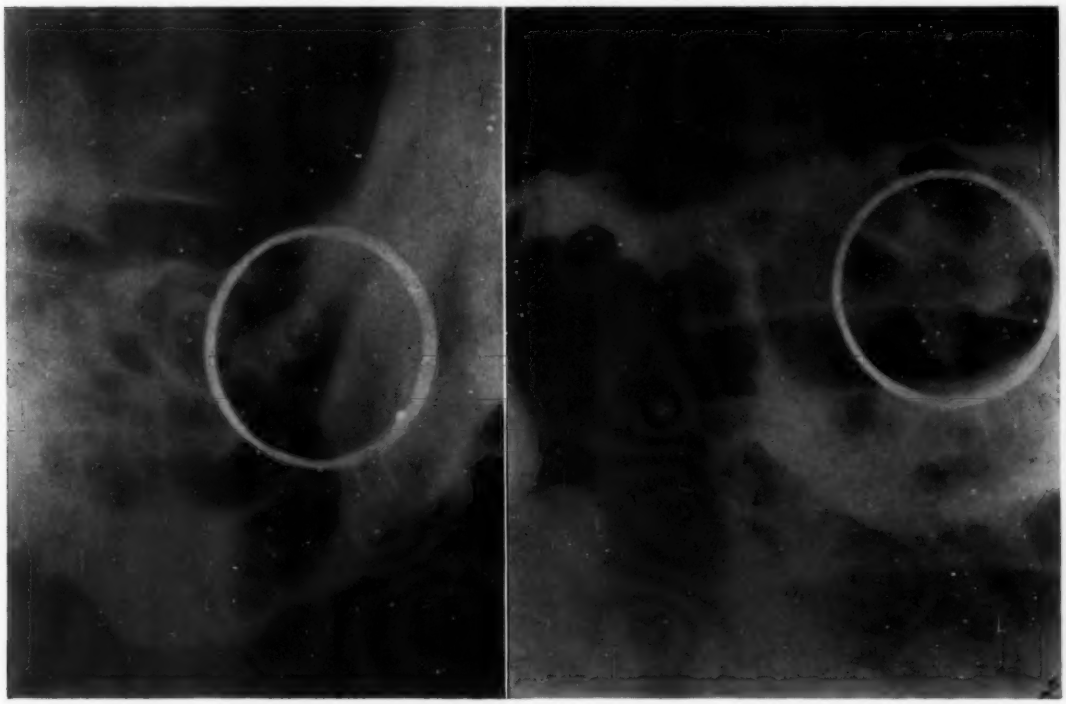

Fig. 3. Case II. Mucosal pattern of the antrum after compression. Note central niche and stellate arrangements of the mucosa.

Fig. 4. Case 11. Altered mucosa of the second portion of the duodenum after compression.

meals, regurgitation, occasional vomiting, which lately had become rather frequent (three to four times weekly). She lost 12 pounds in weight within nine months.

On roentgenological examination, the above discussed changes affecting the antrum and the duodenum were observed. A diagnosis of a lymphoblastoma or granulomatous inflammatory process of stomach and duodenum was made.

Patient was admitted to the hospital following slight improvement after conservative treatment, and an exploratory laparotomy was contemplated.

While in the hospital, patient stated that she had had attacks of severe throbbing pain in the right lower abdomen six years ago. Patient was explored at that time, and told she had an inoperable growth.

Red blood count was 2,850,000, white blood count was 7,350, and hemoglobin 40 per cent. There was no record of gastric analysis.

Patient was operated upon June 17, 1938. A gastric resection was performed, and the removed specimen was described as consisting of approximately the distal one-third of the stomach attached to which were three large smooth, soft lymph nodes. The mucosa of the stomach was markedly hypertrophied, soft, and dark purplish red. There was no evidence of ulceration, and the zones of hypertrophy were fairly distinct. The wall of the stomach was markedly thickened, fibrosed and edematous.

Cut section of the lymph nodes revealed a soft, pale pinkish gray to dark grayish red bulging surface. Throughout, the nodes were fairly discrete, firm yellowish gray areas, varying from 6–12 mm. in diameter.

Microscopic examination showed an enormous infiltration of the stomach wall, which was more or less diffuse and consisted of lymphocytes throughout the mucosa and submucosa and extended into the muscularis. There was an associated diffuse congestion in some areas. The margin of the mucosa was intact.

The lymph nodes of the serosa showed scattered, numerous, histologically typical, both single and conglomerate, tubercles. Caseation was abundant in some sections.

Microscopic Diagnosis: Tuberculous inflammation.

The macroscopic anatomical specimen of this case explains the roentgenological changes noted at the roentgenoscopic examination, and on the films only partly, since the duodenum could not be resected. The hypertrophy of the mucosa with its irregular arrangement could be confirmed. The sharp, semicircular marginal defects were produced by exogastric pressure of the enlarged lymph nodes, so closely attached to the stomach wall. The fibrosis, edema of the

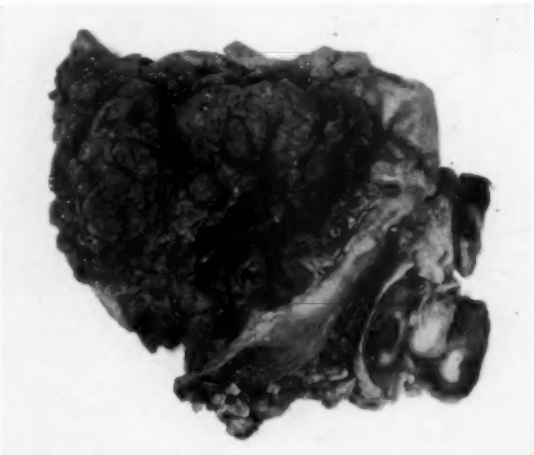

Fig. 5. Case 11. Anatomical specimen. Note the enlarged nodes with central caseation.

gastric wall, and infiltration of the muscularis were responsible for the impaired peristalsis.

Patient died a few days later of peritonitis,

but a postmortem examination could not be obtained.

Case III. J. McC., white male, aged sixty, was admitted to the University Hospital, and gave the following history. For several years patient has had some "indigestion"—slight burning, dull pain in epigastrium; at time attacks of severe epigastric pain occurred. Two and one-half years prior to his admission to the hospital patient became constipated, complained of fullness in abdomen, distention, and finally vomiting. He sought medical advice in a hospital, where a diagnosis of intestinal obstruction was made, and patient was operated at that time. There was no record obtainable of his previous hospitalization. After the operation patient showed gradual slow improvement. He was quite well until about two weeks prior to admission when attacks of epigastric pain and vomiting recurred. In the last few days patient was unable to retain any food. The abdominal pain increased in severity; the abdomen became distended. The patient felt relieved after vomitus or gastric lavage. He lost considerable weight. His voice has been hoarse for some time, and he has been complaining of pain upon swallowing.

On physical examination there was dullness in the left apex, and below the clavicle; tubular breathing in left axilla, occasionally moist râles.

Repeated examinations of the sputum failed to show tubercle bacilli. Examination of the stool revealed occult bleeding.

Roentgenogram of the chest showed a fibrous tuberculosis of the left upper lobe. On roentgenoscopic examination of the stomach the previously described changes were observed.

In view of the pulmonary changes demonstrated on the roentgenogram of the chest, and clinical diagnosis of laryngeal tuberculosis, a possibility of gastric tuberculosis was considered.

This assumption seemed to be justified by the rather atypical appearance of the gastric lesion, which showed presence of mucosa within the defect, suggested several small ulcerations, retained some flexibility of the wall, and apparently involved the base of the duodenum. Because of advanced pulmonary and laryngeal tuberculosis, a surgical intervention was deemed inadvisable, and therefore the patient was treated conservatively.

While in the hospital the patient gained several pounds in weight and showed some improvement in his general condition.

Fig. 6. Case III. Irregular narrowing of the pylorus, and irregularity of the contour of the base of the duodenal cap.

Patient was discharged from the hospital, and advised to return for further observation.

Although we have not been able to confirm the diagnosis of gastric tuberculosis, and though the presence of pulmonary tuberculosis does not necessarily prove the gastric lesion to be of the same nature, we feel that the roentgenological appearance of the described changes, and the clinical course justify this opinion.

Concluding, we would like to stress that so far the roentgenological studies of gastric tuberculosis have been limited to a small number of cases, and the findings have not been sufficiently uniform to permit the formulation of definite differential roentgenological criteria characteristic of tuberculosis only. Some of them seem, however, sufficiently significant, and should lead to a more frequent preoperative roentgenological diagnosis.

SUMMARY

(1) Three cases of gastric tuberculosis have been presented.

(2) The roentgenological manifestations observed in these cases have been described.

(3) Attention has been called to the concomitant affection of the duodenum, which should facilitate the diagnosis of gastric tuberculosis.

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INTESTINAL OBSTRUCTION AT TERMINAL ILEUM CAUSED BY LARGE IRREGULAR GALLSTONE

REPORT OF A CASE

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S.P., white, female, single, aged sixty-one, well nourished, always enjoyed good health except for an illness during childhood which would be diagnosed today as rheumatic fever. She was always told since this illness that she had a bad heart. She was operated upon twenty-one years ago for a ruptured appendix, recovering after a stormy convalescence. Three years before her last illness she was operated upon for a femoral hernia. A heart condition caused complications at that time.

On August 13, 1939, at midnight the patient was first seen by her physician after she had suffered from abdominal discomfort for a week. She had intense pain in the epigastrium, referred to the lower abdomen, accompanied by vomiting. She was advised to enter the hospital for observation and further study.

Examination. Chest showed nothing unusual in the lungs. Heart: apex at fifth interspace near anterior axillary line. Heart border showed enlargement of the heart, preponderance to the left. Auscultation revealed a systolic and diastolic murmur, more pronounced at the apex but heard over the entire precordial area up to axilla and back. Diagnosis of mitral insufficiency and stenosis was made. Abdomen was somewhat distended with some rigidity. No definite tumor mass could be palpated. Auscultation, marked peristalsis but not with the crescendo of a complete obstruction. On palpation, patient had tenderness in the epigastrium as well as in the lower quadrant. Liver border, at the costal margin. Spleen, and kidneys, not palpable. Vaginal examination, nothing remarkable or unusual. Rectal examination, a few internal hemorrhoids; no evidence of mucus or blood. Examination was made after an enema. Extremities, normal.

Family History. No tuberculosis, cancer or diabetes.

Laboratory Examination. Blood chemistry report: Non-protein nitrogen 36, chlorides 495. Blood examination: red blood cells 4,600,000; hemoglobin 90 per cent; color index 0.9; white blood cells 14,900; basophils 1 per cent; eosinophils 2 per cent; lymphocytes 8 per cent; monocytes 2 per cent. Urinalysis, sp. gr. 1.030; negative for albumin; negative for sugar.

Roentgen examination of the abdomen showed distention of the small bowel (Fig 1).

Fig. 1

Diagnosis. Obstruction at terminal ileum. Operation was advised. At 5:10 P.M. on August 15, abdominal operation was performed by the physician who had first examined the patient. Incision was made parallel to the old laparotomy scar. The small bowel was found dilated, with obstruction at the terminal ileum, about 3 inches from the ileocecal valve. Some adhesions in the area caused a partial kink. Just proximal to the adhesions a large hard mass was felt that was causing a definite obstruction. The adhesions were freed. The bowel was opened and a large gallstone removed. The ileum was repaired with No. 1 chromic by closing a longitudinal incision, the lateral approximation of its margins covered by two layers of sutures. The abdomen was closed without drainage;

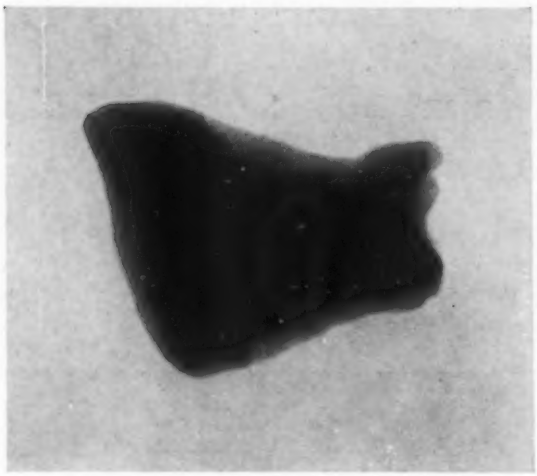

Fig. 2

interrupted chromic was used for peritoneum and fascia, retaining silk and interrupted silk sutures in the skin.

The irregular hard mass which was removed was sent to the laboratory for examination. The report was gallstone, 5×2.5×1.5 cm. in size; a bilirubin cholesterol stone (Fig. 2).

The patient responded to operation with very little reaction and continued to improve until August 19 when she became very weak, fast pulse, 120–130, very irregular. She was confused and somewhat cyanotic. Regardless of stimulation, she continued to grow worse and died on August 21, 1939, at 5:50 P.M. Permission for autopsy was not granted.

The reason for reporting this interesting case is that the roentgenographic examination gave the location of the obstruction but, due to the consistency of the material in the calculus, it failed to reveal the shadow that was the principal cause of the obstruction.

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RESPIRATION PYELOGRAPHY

A STUDY OF RENAL MOTION IN HEALTH AND DISEASE*

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THE study of renal mobility and the development of respiration pyelography was prompted by a desire to improve our ability to diagnose perinephric abscess. The clinical or roentgenologic diagnosis of this condition in an early stage is difficult, requiring the utmost in interpretative judgment on the part of all concerned. Any procedure which will aid in earlier diagnosis of this disease justifies consideration and the elaboration of its technique and usage. Roentgenologic analysis of renal mobility by means of respiration pyelography has helped us to diagnose several cases of perinephric infection, and has given us information of value in certain other renal and perirenal diseases.

My particular interest in renal mobility was initiated in November, 1936, by a case of perinephric abscess in which I was able to demonstrate roentgenoscopically lack of motion in the kidney area.

Case 1. B. M., male, aged seven. Admitted to Hamot Hospital with complaints of three weeks' duration: fatigue, lassitude, afternoon temperature elevation, and slight discomfort in the right lumbar area; white blood count, 26,500. There was neither tenderness nor fullness in the lumbar area.

Roentgen study of November 7, 1936, showed the right-sided liver shadow to be slightly enlarged. The right hemidiaphragm was elevated; its motion was nearly normal. During roentgenoscopy, the lower margin of the liver stood out sharply against the gas-filled intestinal loops. It was observed that the posterior half of the lower liver margin did not move with respiration. A tentative diagnosis was made of "an inflammatory process involving the posterior inferior surface of the liver."

Operative finding: A right upper pole perinephric abscess; organism was *Staphylococcus aureus*.

TECHNIQUE

Because of the roentgenoscopic demonstration of limitation of motion of the right hepatorenal area in this case, the problem of renal mobility was considered for some time. How could renal motion be evaluated in the routine case? Respiration pyelography, earlier known as "double pyelograms," was begun in July, 1937. The earlier technique has not been substantially modified. The customary bilateral retrograde pyelogram is taken, and followed immediately with the respiration film. If the catheters are clamped after injection, it is usually not necessary to refill the kidneys with opaque material. At times the excretory urogram is sufficiently dense to permit respiration study. A single film is exposed twice: first, with the patient in extreme inspiration, and then, with the patient in forced expiration. With our equipment, the Potter-Bucky diaphragm is re-set for the second exposure. The intensity for each exposure, in terms of milliampere-seconds, is 75 per cent of the intensity required for the usual single-phase pyelogram. An overexposed film is the result, upon which may be seen, on each side in the normal, a double pyelo-ureterogram (see Fig. 1).

The patient is carefully instructed in the need for his cooperation. Obviously, the breathing must be essentially abdominal rather than costal; in fact, the instruction is to "breathe with your stomach." The body should not be allowed to shift its position in the respiratory change, and the customary compression band, lightly applied, helps somewhat in this respect. The unintelligent, uncooperative patient is not a fit subject for respiration pyelography.

The kidney does not move normally un-

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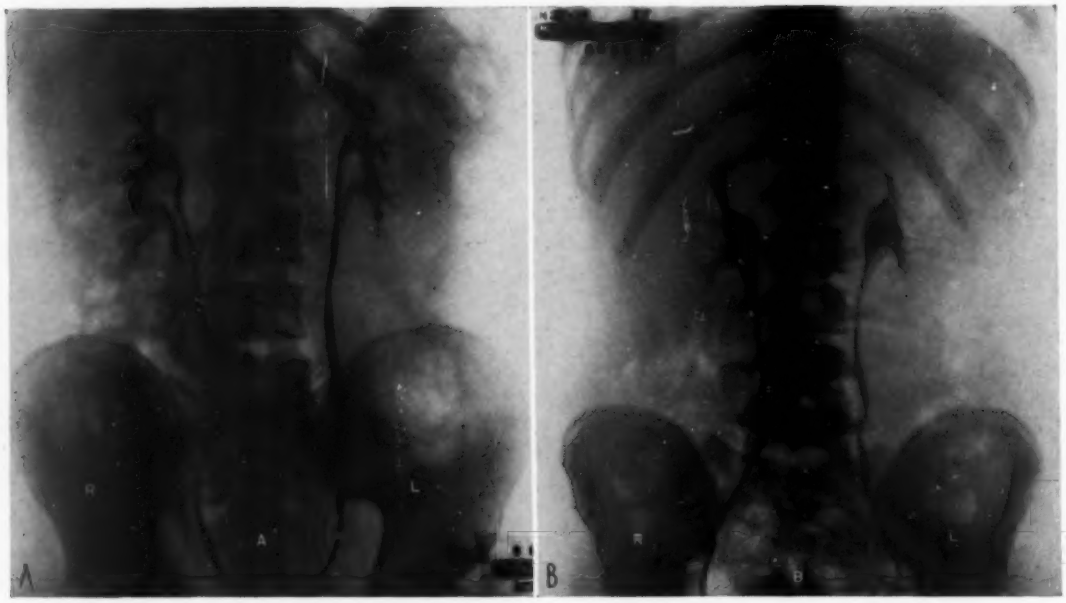

Fig. 1. Normal mobility. *A*, respiration pyelogram shows average renal motion bilaterally, associated with satisfactory diaphragmatic excursion. *B*, respiration pyelogram shows minimal renal motion bilaterally, due to costal type of breathing with slight diaphragmatic excursion.

less the corresponding hemidiaphragm also moves normally. This motion is occasionally apparent on the film; if not, roentgenoscopy of the diaphragm is imperative, if accurate conclusions are to be reached concerning renal mobility. Since rational conclusions depend primarily upon a comparison between the motion of the two kidneys, bilateral pyelography is desirable. Where only a unilateral pyelogram is made, a sufficiently accurate interpretation can be made only if the diaphragmatic excursion has been moderate or wide in extent.

Gross renal motion is estimated by a study of the shift of any contrast-filled unit of the kidney. The superior and inferior margins of the pelvis are usually well seen and lend themselves best to measurement. Occasionally, isolated calyces must be used to determine the respiratory shift. A close study of the entire diphasic pyelo-ureterogram gives additional information as to direction, extent and type of motion of the various parts. Ureteropelvic abnormalities, for instance, may be better understood.

HISTORY

Previous work has been done with regard to renal motion, and its significance. Mathé, in 1925, demonstrated "lack of renal mobility in perinephritic abscess" in a totally different manner, which he still employs. He studies the kidney's postural shift in the change from the horizontal to the erect position. Separate pyelograms are exposed: with the patient horizontal, vertical, and in the Trendelenburg position. The normal kidney moves downward more than 3 cm. by the shift from horizontal to vertical; lack of such postural mobility is considered, by Mathé and others, a valuable sign in differential diagnosis. Postural mobility studies have been invaluable in the analysis of ptosis and obstructive lesions at the ureteropelvic junction.

How much postural mobility the kidney is entitled to is a moot question, judging from the statements of several observers. Smith, McKim, and Rush have said that "normal renal mobility is never in excess of 2.5 cm. Although movement in excess of this figure is not infrequently found, it can no more be regarded as anatomically nor-

mal than can the relaxed abdominal wall of the multipara." Deming, earlier, had maintained that "movement of more than 4 cm. is indicative of an abnormal excursion for the kidney." It is obvious that the postural excursion will depend to some extent upon how much the respiration act has been allowed to participate. For instance, Deming, by exposing his supine film in expiration and his erect film in inspiration obtained a renal shift amounting to from 6 to 8 cm. This displacement is due to postural shift plus respiratory shift.

Hess, in 1931, mentioned in a discussion before the urologic section of the Pan American Medical Association that "the pyelogram taken in inspiration and expiration would demonstrate the non-fixation of the normal kidney." Chevassu, in 1933, in a case of perinephric infection, was satisfied, during pyeloscopy, that the contrast-filled kidney pelvis "appeared absolutely motionless" during deepest inhalation. Many others, before and after Chevassu, have observed the respiratory motion of the pyelo-ureterogram during pyeloscopy.

Hilgenfeldt reported late in 1936 on a series of cases in which he had employed a procedure which he termed "respiratory pyelography"; he indicated its usefulness in the diagnosis of perinephric abscess. Breuer has used the same method in the diagnosis of 3 cases of perinephric abscess.

Hilgenfeldt's work goes back over a period of five years, from which time he reported approximately 20 cases of infection outside of and within the kidney. His preferred technique is to expose two films, one at deep inspiration, one in forced expiration. The tracings from these negatives are then studied in relation to one another, and their variations recorded. The contrast-filled normal kidney moves anywhere from 1.5 to 6 cm. With children, Hilgenfeldt uses Mathé's postural method: a comparison of the pyelogram displacement from the horizontal to the erect posture.

Renal mobility is ascribed to movement of the corresponding hemidiaphragm imparted through the fascial framework of the kidney. Therefore, the diaphragm must move normally if the examination is to be of any value. When the diaphragm is paralyzed and moves upward (paradoxically) on inspiration, the subjacent normal kidney also moves upward. When the hemidiaphragm does not move with respiration, the subjacent kidney moves only slightly outward, due to the effect of the excursion of the contralateral hemidiaphragm.

Edema and inflammation of the fibrous bundles in the perirenal adipose tissue account for fixation of the perirenal fascia and kidney. Hilgenfeldt has found his method of study useful, not only in perirenal infection but also in advanced pyonephrosis and the localization of calculi and foreign bodies. He recommends its routine employment during pyelographic study.

MECHANISM OF RENAL MOTION

The kidney is enclosed within two layers of fascia which are continuous downward over the ureter and renal vessels. Renal motion, according to Hilgenfeldt, depends primarily upon the attachment of the prerenal fascia upward over the colon and duodenum, and into the diaphragm. This same student calls attention also to the action of the overlying abdominal muscles and to the motion transmitted as the result of contralateral diaphragmatic excursion. Perhaps the manner of vascular attachment at the pedicle is of importance. In our opinion, an additional factor must be considered: the mass motion set up against the superior pole of the kidney by actual pressure and motion of the diaphragm (and liver).

Pyeloscopy in the anteroposterior and lateral projections strengthens this impression. The upper third of the normally placed kidney lies anterior to the posterior fibers of the diaphragm. As these fibers contract, the superior renal pole bends forward slightly; with the descent of the dome which occurs later in the inspiratory phase, the kidney and its bed move correspondingly downward and slightly outward. Thus the inspiratory act in its order includes contraction of the muscular ele-

ments of the diaphragm, anteroflexion of the superior renal pole, descent of the diaphragmatic dome, followed by the subphrenic structures, including the kidney and ureter in their fascial envelope. The effect upon the kidney is essentially that of a forward and a downward displacement, essentially a squeezing motion, caused by diaphragmatic pressure.

EXPERIENCE WITH RESPIRATION PYELOGRAPHY

We have used respiration pyelography in more than 200 patients. Employed as a routine procedure for several months, the recent tendency has been to select the patients to be examined—based on the clinical diagnosis, and the wet-film reading of the pyelogram. If gross renal disease is apparent, or if perinephric abscess is suspected, respiratory motion is investigated in the supine position. On several occasions, the cystoscopic procedure has been repeated in order to get the additional information furnished from the respiration film. Perhaps Hilgenfeldt is correct in his contention that respiratory motion should be recorded in all cases.

Thus far the study has been made by superimposing the two exposures on a single film. No practical advantage is seen in the Hilgenfeldt two-film procedure which is more complicated and admits of more technical error; his method is more time consuming from both the technical and the interpretative standpoints.

The erect posture has also been utilized for estimating respiratory mobility. In the few normal cases studied, the respiratory shift has averaged the same in the erect as in the supine position.

Normal Motion. Renal mobility could be estimated on 90 per cent of patients routinely studied; no interpretation was attempted where the motion was less than 1 cm. on one or the other side. In a series of 86 patients who had roentgenographically negative pyelograms (Table 1) the average craniocaudad excursion of the right and the left kidney was found to be the same —2.75 cm. Fifty per cent of the kidneys moved more than 3 cm. during the respiratory shift. The outward, or mesiolateral, movement of the pyelogram amounted to less than 0.33 cm., in the average; the lower part of the kidney moved slightly more than the superior pole.

Table I

AVERAGE RESPIRATORY MOTION OF ROENTGENOLOGICALLY NEGATIVE PYELOGRAMS

86 patients

Right Kidney Motion (75 cases)	
Superior calyx craniocaudad	2.75 cm.
Ureteropelvic craniocaudad	2.69 cm.
Superior calyx mesiolateral	0.24 cm.
Ureteropelvic mesiolateral	0.27 cm.
Left Kidney Motion (82 cases)	
Superior calyx craniocaudad	2.75 cm.
Ureteropelvic craniocaudad	2.57 cm.
Superior calyx mesiolateral	0.25 cm.
Ureteropelvic mesiolateral	0.33 cm.

The variation in normal renal mobility between patients may be considerable; for that matter, renal motion may be quite different at different times in the same patient, and yet be within normal limits. One such patient recorded respiratory motion of 4.5 cm., and thirty minutes later, of 9.5 cm. This wide variation is ascribed to the type of diaphragmatic effort achieved in the extremes of respiration. For this reason, motion has been considered normal when it is nearly the same on each side; a discrepancy of more than 25 per cent has arbitrarily been considered significant of altered mobility. It is worthy of reëmphasis that diaphragmatic motion on both sides must be normal before any conclusion can be reached with regard to renal mobility.

Renal excursion may depend upon certain other less tangible factors (Fig. 2). For instance, a patient with extreme lumbar scoliosis exhibited immobility of the right kidney; there was no other evidence of renal or perirenal disease. Perhaps the explanation lies in the disturbed position of the right kidney; lying on the concave side of the spine, the kidney mass was too remote from the diaphragmatic mass (and fascial)

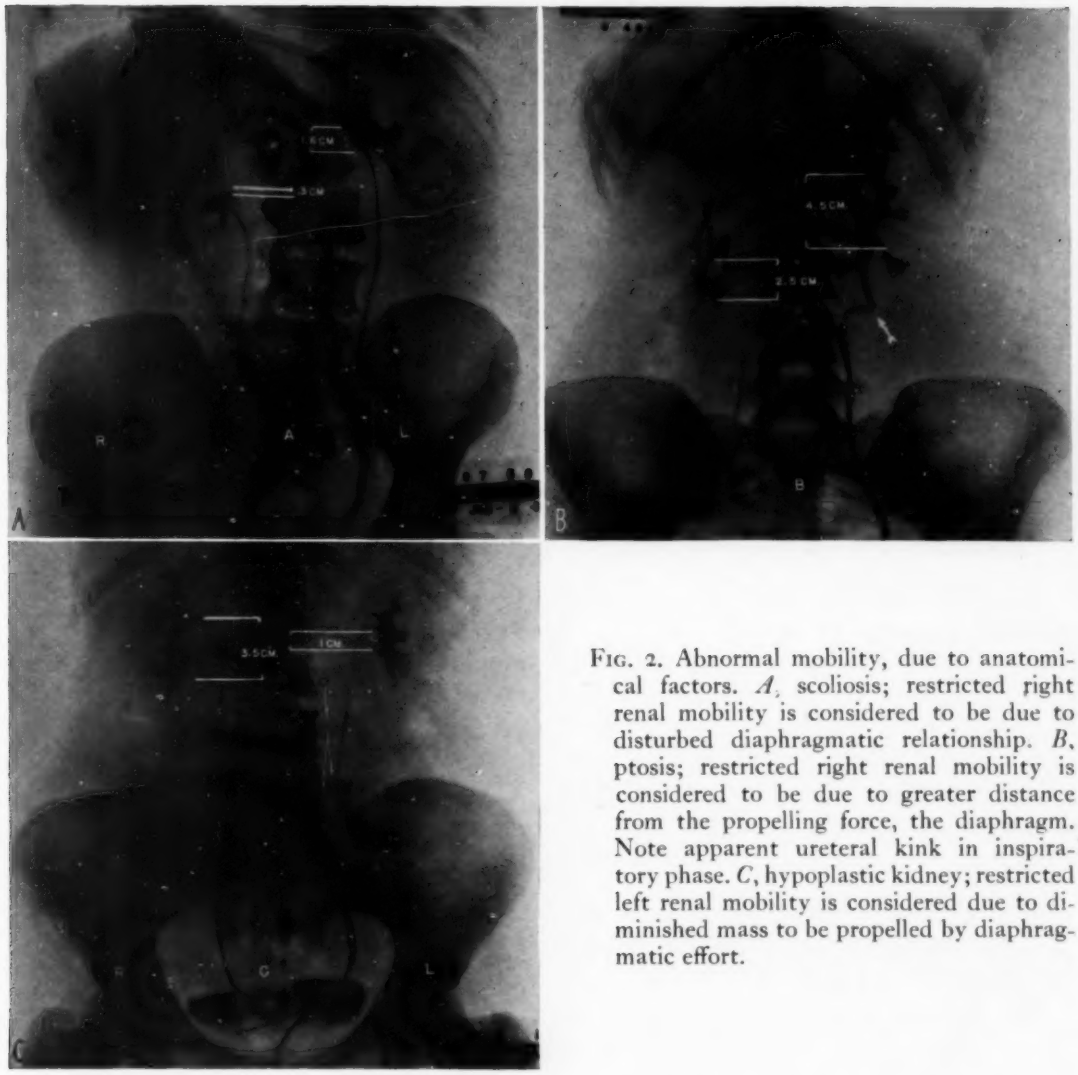

Fig. 2. Abnormal mobility, due to anatomical factors. *A*, scoliosis; restricted right renal mobility is considered to be due to disturbed diaphragmatic relationship. *B*, ptosis; restricted right renal mobility is considered to be due to greater distance from the propelling force, the diaphragm. Note apparent ureteral kink in inspiratory phase. *C*, hypoplastic kidney; restricted left renal mobility is considered due to diminished mass to be propelled by diaphragmatic effort.

motion. Hilgenfeldt noted that "abnormally deeply placed kidneys are slightly movable and tend to turn themselves diagonally on deep inspiration. Renal mobility cannot accurately be estimated in such cases."

That the low kidney moves less than its higher placed fellow is indicated by an analysis of the relation of renal position to respiratory motion (Table II). In reviewing 50 pyelographicallly negative kidneys, the following data were obtained:

1. Thirteen kidneys, located at or above the first lumbar vertebral body, moved an average of 2.9 cm. each.
2. Twenty-nine kidneys, located on a level with the first lumbar interspace or the second lumbar vertebral body, moved an average of 2.7 cm. each.
3. Eight kidneys, located at or below the second lumbar interspace, moved an average of 1.7 cm. each.
4. In 6 patients with low kidneys, the contralateral higher pyelogram moved an average of 0.75 cm. more than did its lower placed fellow.

Whether this discrepancy in motion of the "ptotic" kidney is a result of ureteropelvic "drag," or is due to the greater distance between kidney and its propelling force, the diaphragm, is not clearly understood. The respiratory mobility is probably

TABLE II

AVERAGE RESPIRATORY MOTION, IN RELATION TO POSITION, OF ROENTGENOLOGICALLY NEGATIVE PYELOGRAMS

(Position: ureteropelvic junction in expiratory phase)

25 cases

Position	L. I or above	L. II	Below L. II	Total
Number	13	29	8	50
Average motion	2.9 cm.	2.7 cm.	1.7 cm.	2.6 cm.

Analysis of Motion of 6 Low Kidneys, and Contralateral Higher Kidneys

Position	Below Level of L. II	At or Above Level of L. II
Number	6	6
Average motion	1.9 cm.	2.65 cm.

no index of the movability of a "movable" kidney. One such case which descended 6 cm. on postural change from the supine to the erect position, demonstrated a respiratory shift of but 1.5 cm. in the supine position, of 1.0 cm., in the erect position.

The size of the kidney mass seems to be of importance. Two hypoplastic kidneys showed an average respiratory shift of 0.7 cm., as compared with 2.5 cm. on the opposite side.

The respiratory pyelogram demonstrates features of interest, and perhaps of definite value in renal anomalies: rotated kidney, double pelvis, double pelvis and ureter, and fused kidney. The anatomy in such cases is more clearly shown by this procedure, even though mobility is not significantly altered.

Abnormal Motion. Something may be said of mobility of the upper half of the ureter, by study of the respiration film. The upper ureter moves similarly to the renal pelvis. Not uncommonly a ureter straight in expiration is extremely tortuous and even acutely kinked on inspiration. An adherent ureter, or a ureter restricted by an aberrant vessel or fascial band, exhibits at the point of involvement little or no vertical shift with respiration. The pipestem tuberculous ureter moves as a unit, retaining its rigidity.

Respiration pyelography in our hands has not been particularly helpful in the diagnosis or localization of urinary tract calculi, although Hilgenfeldt stresses its

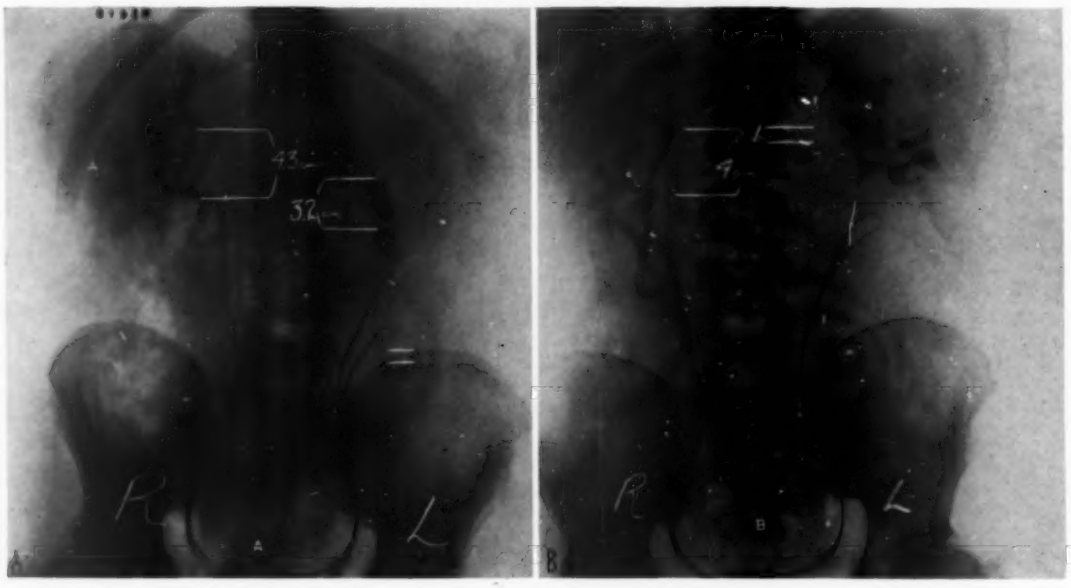

FIG. 3. Left calculus nephrosis, perinephric adhesions. *A*, large obstructing stone in left pelvis. Motion on left side is restricted, due probably to nephrosis with perirenal extension. Note apparent kinks in right upper ureter. *B*, following nephrolithotomy, with large hydronephrosis now demonstrated. Greater restriction in mobility is considered due to increased perirenal adhesions, following surgical trauma.

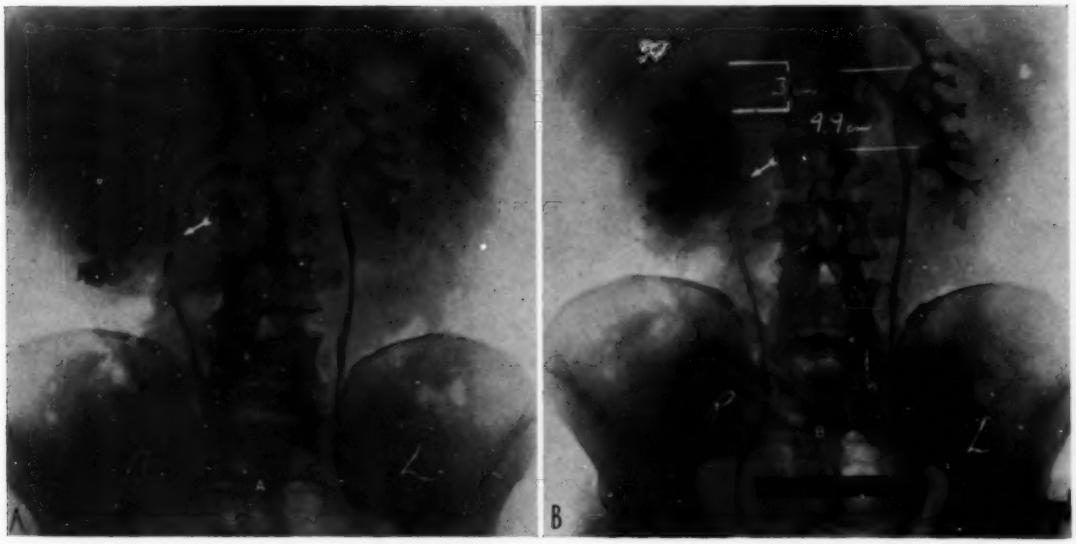

Fig. 4. Right nephrosis, due to upper ureteral stricture. Perinephric adhesions. *A*, pyelogram shows right nephrosis with ureteropelvic narrowing. *B*, respiration film shows considerable restriction in right renal motion, indicating perinephric involvement. Upper ureter remains narrowed. Findings confirmed at operation.

usefulness in this condition. In a few cases of completely obstructing upper ureteral calculus in which the pelvis could not be filled, the extent of motion exhibited by the calculus was an approximate index of renal mobility, and hence of perirenal involvement (Fig. 3).

Restricted renal mobility or fixation, in the absence of diaphragmatic limitation, implies perirenal disease. Any process that causes edema or inflammation of the perirenal fascia or of the adipose tissue between the capsule and fascia hinders free movement of the kidney. Twenty per cent of the patients studied have exhibited altered renal mobility.

Several cases of moderate pyonephrosis demonstrated restricted renal mobility, indicating that the inflammatory process had penetrated the cortex and infiltrated the capsule. In some of these cases, the demonstration of this finding influenced the opinion of the urologist as to the necessity for nephrectomy (Fig. 4). Another effect has been to forewarn the operator of the likelihood of extensive perirenal adhesions, and therefore a more difficult surgical procedure.

Information may be given as to the extent of a tuberculosis of the kidney, or a diffuse cellulitis; the mode of therapy may be definitely influenced. Renal parenchymal tumor has been more accurately evaluated after the degree of renal mobility has been ascertained (Fig 5).

PERINEPHRIC ABSCESS

Respiration pyelography finds its justification in the estimation of renal mobility in those cases of perirenal disease in which there is little or no gross involvement of the kidney itself, notably perinephric abscess of the metastatic variety. The course of perinephric abscess is usually insidious, owing its origin to a prior local trauma, renal disease, nearby infection or a septic focus elsewhere in the body. There is commonly a prolonged period of indefinite lumbar backache and daily temperature elevation; leukocytosis is frequently present. In this stage the astute clinician may suspect the correct diagnosis. Unfortunately, many cases are not diagnosed until the later stage of localized pain, swelling, and tenderness, and perhaps even fluctuation.

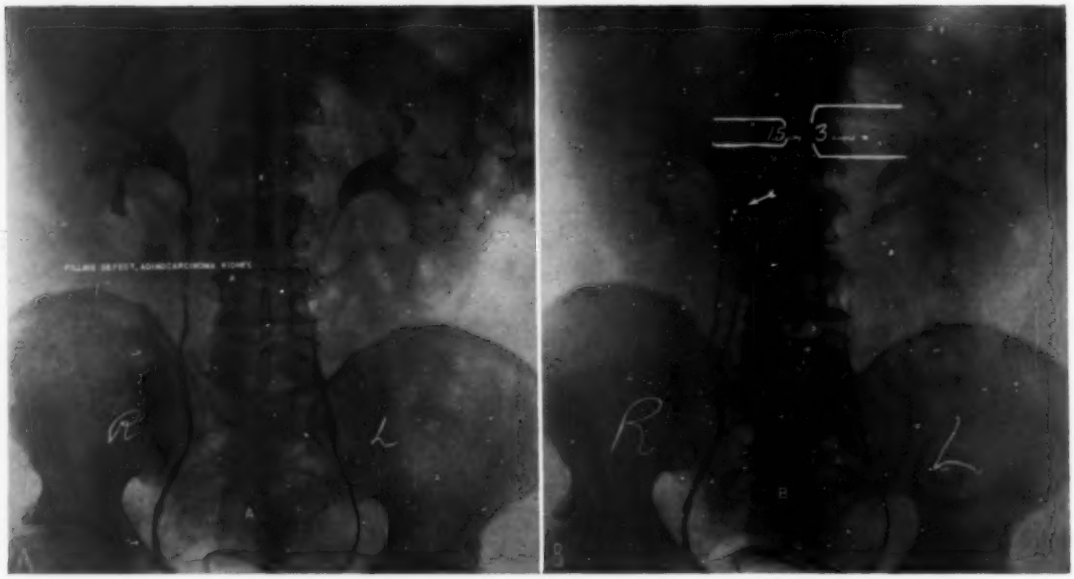

Fig. 5. Right hypernephroma. Perinephric extension. *A*, note filling defects of right pelvis, and superior calyx, and upper half of ureter. *B*, restricted right renal motion, due to perinephric involvement. Ureteral deformity is more clearly visualized. Note lateral motion of ureter. Findings confirmed at operation.

Numerous roentgen findings have been advanced from time to time, all of which have merit, but none of which is entirely reliable. These may be named briefly: the narrowed costo-iliac space, with scoliosis; obscuration of the twelfth rib and lumbar transverse processes; obliteration of the psoas muscle margin—considered a most constant finding by Goldstein and Ostro. However, the psoas margin is obscured in 10 per cent of roentgenograms of patients without perinephric abscess, according to Shane and Harris. Accentuation of the kidney capsule has been emphasized by certain writers. Adjacent structures—the kidney, the colon, the diaphragm—may be displaced. The diaphragm is not immobilized unless the abscess has become paranephric and essentially subphrenic in location.

Anterior displacement of the kidney on the lateral pyelogram has been described by John Menville. Shiflett, in discussing the use of the lateral pyelogram in selected cases, states that, in perinephric abscess, "... the entire kidney may be displaced anteriorly, both poles about the same. When there is unipolar rotation, the lower pole has always been the rotated one."

By means of respiration pyelography, we have found the kidney fixed in 3 cases of perinephric abscess and in 1 case with multiple renal and perirenal abscesses. This finding, fixation, is diagnostic, in the presence of satisfactory diaphragmatic motion.

Previous perinephric inflammation will, of course, destroy renal mobility. In this connection, it is worth while to mention several instances of fixed kidney studied, in which perirenal sympathectomy without nephropexy had been performed months and years before by our colleague, Elmer Hess. The principle of renal fixation as the result of perirenal adhesions is satisfactorily demonstrated in this series (Fig. 6).

As has been emphasized before, diaphragmatic motion must be normal. The diaphragm is immobilized as a result of phrenic nerve disease or interruption, or in connection with intrathoracic lesions, pleurisy, pneumonia, etc.; fixation occurs early in subphrenic abscess, severe liver infections, and acute peritonitis. The study of respiratory mobility in this group of cases is without value.

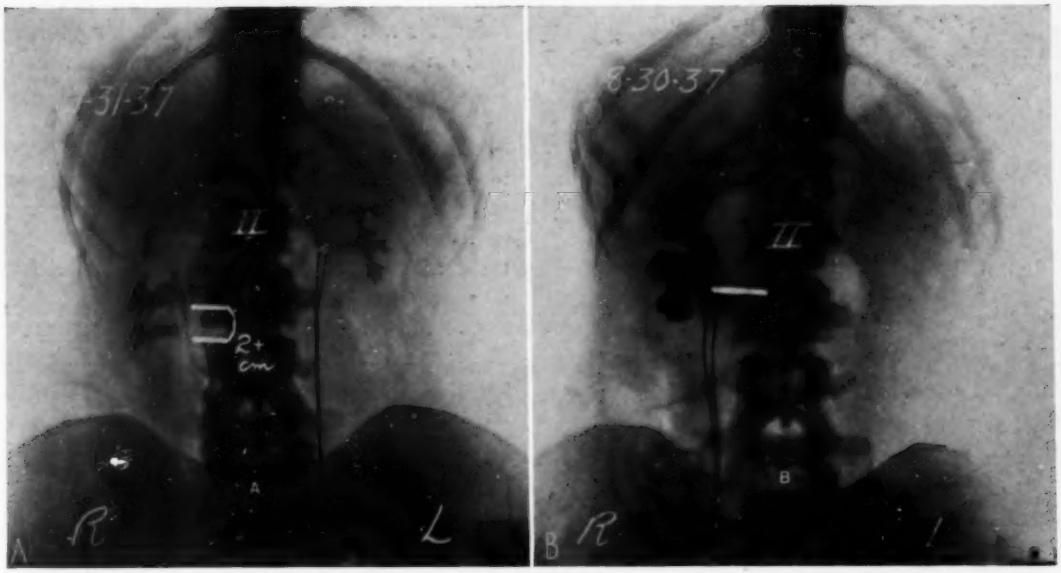

Fig. 6. Perinephric adhesions following perirenal sympathectomy. *A*, before operation. The right kidney, low in position, moves 2 cm. *B*, one month after perirenal sympathectomy *without* nephropexy. No vertical motion is present. Lateral shift is due largely to contralateral diaphragmatic effort.

CASE REPORTS

Fixed Kidney—Acute Kidney Infection with Multiple Abscesses

Case II. V. G., male, aged forty-one.

Clinical Summary. Admitted to St. Vincent's Hospital, April 30, 1938. One month, daily temperature elevation to 100° F.; pain in right lower quadrant, very severe on admission. History of previous kidney infection.

Urological Summary. Acute cystitis; right ureteral urine loaded with pus cells; smear and culture negative. Right pyonephrosis with calculi. Respiratory motion: Right: 0.5 cm. Diaphragm moved well. Left: 3 cm.

Summary. Right, nearly fixed kidney—"acute kidney infection." Left, normal wide excursion.

Treatment. Right nephrectomy; marked perinephric adhesions found.

Pathology. "Right kidney and perirenal tissue showing marked localized abscesses and chronic inflammatory reaction. Small stone found in kidney pelvis which is not markedly distended."

Comment. That nephrectomy would be necessary was prophesied on the basis of the restricted renal mobility. The limitation of motion was out of all proportion to the amount of renal damage as indicated by the preoperative urologic and pyelographic studies.

Fixed Kidney—Perinephric Abscess

Case III. A. P., male, aged thirty-six.

Clinical Summary. Admitted to St. Vincent's Hospital, November 21, 1937. Complaint was of right hip pain, not aggravated by motion, for

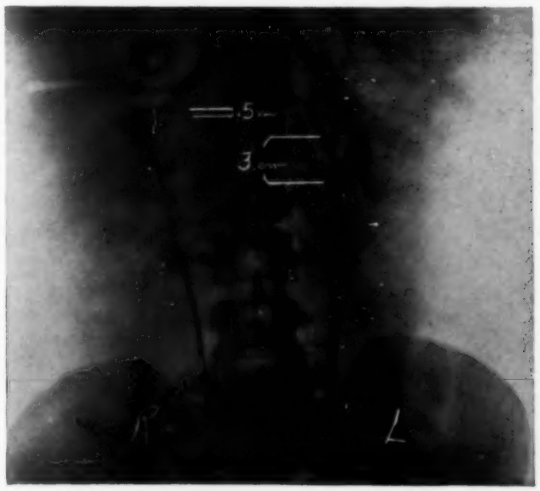

Fig. 7. Case II. Right multiple renal and perinephric abscesses; calculus nephrosis. Fixed kidney, indicating perinephric involvement. On preliminary films, psoas margin is indistinctly seen. Findings confirmed at operation.

Fig. 8. Case III. Right perinephric abscess. Fixed kidney, indicating perinephric infection; confirms clinical and other roentgen findings. Findings confirmed at operation.

a duration of three weeks. On December 4, two weeks after admission, tenderness was made out in the right lumbar area. White blood count, 17,000, with 84 per cent polymorphonuclears. Lumbosacral spine roentgen study, November 29, was interpreted as negative; later review indicated loss of right psoas shadow.

Urological Summary. Ureteral urine from both sides contained red blood cells, and *Staphylococcus albus* was cultured from each side. December 4, right psoas margin obscuration; hepatic flexure of the colon displaced downward and mesially; right pyelogram displaced outward. Respiratory motion: Right: 0.3 cm. Diaphragm moved well. Left: 1.6 cm.

Summary. Right, fixed kidney; left, normal narrow excursion.

Treatment. Incision and drainage through right lumbar incision; large right perinephric abscess (1,000 cc. of pus) evacuated.

Comment. The diagnosis in this case was obvious before renal motion was estimated; respiration pyelography was confirmatory of perirenal involvement.

Fixed Kidney—Perinephric Abscess

Case IV. L. R., male, aged forty-one.

Clinical Summary. Admitted to St. Vincent's Hospital, November 8, 1938. Onset of illness was nine days before admission, when patient noticed headache, anorexia, and malaise. Considerable muscle soreness and aching followed, and on several occasions there was vomiting. On the next day, several transient lancinating pains were noticed in the right groin. The pains became gradually more severe, and three days later were felt in the right flank; soreness in this latter area developed about this time, four or five days after admission. In 1931, the patient had been ill for seven weeks, with what was probably a pyelonephritis. On admission, slight tenderness and fullness were present in the right flank and upper abdomen. Temperature rose to 101° F. White blood count, 15,400, with 92 per cent polymorphonuclears.

Urological Summary. Ureteral specimens contained a few red blood cells; a sparse culture of *Staphylococcus albus* was obtained from both specimens. On pyelography, the right psoas margin could not be made out. Slight nephrosis was present on the right side, with the pelvis not displaced, but somewhat shortened in its vertical length. Respiratory motion: Right: 0.7 cm. Diaphragm moved well. Left: 2.5 cm.

Summary. Right, fixed kidney; left, normal average excursion.

Treatment. Incision and drainage through right lumbar incision. There was found a large abscess of the right flank extending from the diaphragm into the right iliac fossa; 300 cc. of pus were evacuated.

Pathology. The smear showed a few gram-positive chain cocci; culture was negative.

Fig. 9. Case IV. Right perinephric abscess. Fixed kidney, indicating perinephric infection; confirms clinical and other roentgen findings. Findings confirmed at operation.

Comment. Lack of respiratory mobility was a confirmatory finding in this case.

Fixed Kidney—Perinephric Abscess

Case v. D. G., female, aged twenty.

Clinical Summary. Admitted to St. Vincent's Hospital, February 7, 1938. Patient was delivered on that day of a full-term still-born child; there was a second-degree tear, treated by immediate repair. Beginning the third day, a temperature rising to 103° F. each afternoon developed and continued to the twentieth day, without satisfactory explanation. All laboratory, roentgen, and clinical studies were negative. The patient received two transfusions and her illness was considered as a mild postpartum infection. No localizing pain or tenderness was noted at any time. On March 2 a

Fig. 10. Case v. Left perinephric abscess. Fixed kidney, indicating perinephric infection. No clinical evidence at this time; left psoas margin is obliterated. Findings confirmed at operation.

respiratory pyelogram was advised as an investigative procedure.

Urological Summary. Left ureteral urine: cloudy with occasional epithelial cells, few bacteria—*B. coli*, *Staphylococcus albus*. Respiratory motion: Right: not done. Left: 0.4 cm. Diaphragm moved widely.

Summary. Left fixed kidney.

Treatment. Incision and drainage through left lumbar incision; perinephric abscess about left kidney.

Pathology. Streptococcus haemolyticus and *Staphylococcus albus.*

Comment. Two days elapsed after the respiration pyelogram demonstrated a fixed kidney, before the attending physician could be convinced that a diagnosis of perinephric abscess was warranted. How long before localizing symptoms or signs would have developed is problematic.

DISCUSSION

Respiration pyelography has been used in more than 200 patients during the past three years, in order to determine its usefulness and its indications. In no way does the motion study replace routine pyelography; rather does respiration pyelography supplement the customary study.

Where a knowledge of restricted renal or ureteral mobility will be of value, respiration study in the supine position is indicated. We prefer respiration pyelography to postural study in this group of cases, because of the ease and accuracy with which the former procedure may be carried out—as a routine, if desired.

Where the problem is one of excessive mobility and ureteral obstruction, the behavior of the upper urinary tract must be investigated in the supine and in the erect postures. The essential inspiration exposure may be advantageously supplemented by a diphasic film, from which may be obtained information regarding the relationship of the several parts in the two phases of respiration.

I have no argument with the observer who is able to do routine pyeloscopy, serial pyelography, or cinex camera study. Respiration pyelography is recommended as a simple supplementary roentgenographic procedure capable of producing accurately a permanent record of the phenomenon of renal motion.

SUMMARY

1. Single-film respiration pyelography is a simple technical procedure which can be utilized wherever pyelography is done.

2. Renal mobility can be estimated in 90 per cent of cases studied in this manner.

3. Since the perirenal fascia is a direct

extension from the diaphragm, a movable diaphragm is a *sine qua non* for normal renal mobility.

4. Renal and ureteral anomalies are more adequately demonstrated by means of respiration pyelography than by simple pyelography.

5. The estimation of renal mobility in the case of calculus, in pyonephrosis, and in parenchymal and cortical renal lesions gives information of value which is obtainable in no other manner.

6. Respiration pyelography is a valuable diagnostic procedure in perinephric abscess; renal fixation indicates perirenal involvement.

7. The development and use of respiration pyelography have stimulated a sharper interest in the behavior of the diaphragm and adjacent structures in health and disease; much remains to be investigated with regard to renal motion.

I am indebted particularly to my senior associate, Dr. B. Swayne Putts, for his friendly criticism and many suggestions throughout the period of this study. Acknowledgment is made to Dr. G. Wm. Schlindwein, Dr. Elmer Hess, chief urologist at St. Vincent's Hospital and attending urologist at Hamot Hospital; to Dr. Maxwell Lick, attending urologist at Hamot Hospital; and to their several associates, for their helpful interest and cooperation. Without the willing and intelligent assistance of the technicians in the roentgenologic departments of the two hospitals this work would have been much more difficult and less complete.

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VOL. 44, NO. 1

EXPERIENCES IN THE TREATMENT OF PRIMARY SKELETAL SARCOMA BY IRRADIATION*

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A REVIEW of the literature indicates that primary malignant tumors of bone have not often been controlled by irradiation alone. Reports of treatment by various procedures clearly show that the best results have been obtained where some type of rather radical surgical procedure has been performed together with irradiation and in some instances Coley's toxins. Because radiation therapy has in some cases resulted in prolonged control of the neoplasms and because aside from surgical procedures there is no other treatment which offers possibilities for control of the growths, further study of this type of treatment is in order.

In the literature there are scattered reports of individual or small groups of cases that have survived for long periods following irradiation. Meyerding[1] of the Mayo Clinic has summarized the results of treatment of patients with various types of primary malignant bone tumors seen from 1909 through 1934, and cited 37 patients treated by irradiation alone of which 6, or 16 per cent, survived three years and 3, or 9 per cent, survived five years or more. Engels[2] cited 35 cases treated between 1925 and 1933 by irradiation only, of which 7, or 20 per cent, were reported well after five years. However, from the roentgenograms and photomicrographs accompanying this report the final diagnosis of primary malignant tumor of bone might well be questioned in some cases. Simmons,[3] in a review of 47 patients with primary malignant tumors of bone seen in the Massachusetts General Hospital between 1920 and 1932, cited 6 cases treated by irradiation alone with no prolonged survival.

The purpose of the following report is to record the experiences in the University of Chicago Clinics (1931 to 1936) with radiation therapy in the treatment of primary malignant bone tumors. In all patients the diagnosis was confirmed by biopsy. *Only those cases are considered where irradiation was the sole treatment or where a surgical procedure, if performed, was conservative in type and would alone appear to be inadequate*

FIG. 1. *A*, large chondrosarcoma arising in left sacroiliac joint (outlined on film). *B*, appearance of neoplasm seven years later after tumor dose of 13,000 r delivered over period of five and a half years. There has been some increase in size and diffuse calcification or ossification. In 1939 there was still no evidence of distant metastases.

* From the Department of Surgery and the Division of Roentgenology of the Department of Medicine, the University of Chicago Clinics. Read at the Fortieth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 19–22, 1939.

TABLE I

FAVORABLE RESULTS OBTAINED IN TREATMENT OF BONE TUMORS BY IRRADIATION*

Patient	Age and Sex	Neoplasm	Treatment. Estimated Tumor Dose and Time of Treatment	Clinical Course	Result—Survival after Treatment**
Ar. Cl. 38806 (Fig. 1)	34 yr. ♂	Chondrosarcoma left sacroiliac joint (12 cm. in diameter protruding into pelvis)	13,000 r at intervals over 5½ years	Very slight increase in size of tumor and partial calcification over 7½ years. Recent small increase in size. No pulmonary metastases (August, 1939)	Fairly good clinical condition 8 years
Guld 103984 (Fig. 2)	23 yr. ♂	Chondrosarcoma upper end right humerus, 5×3 cm.	Local curettage followed by 7500 r in 60 days	Moderate atrophy of muscles of right shoulder	Clinically well 6 years 3 months
Dubsk 163593 (Fig. 3)	23 yr. ♀	Fibrosarcoma right ilium and acetabulum about 8 cm. in diameter	3600 r over period of 6 months followed by local curettage of lesion	No symptoms of active disease	Clinically well 4 years
Cade 83558 (Fig. 4)	21 yr. ♂	Ewing's sarcoma, diffuse involvement of two-thirds of ala of sacrum and involvement of sacroiliac joint	3730 r over 3 months	Six months after beginning treatment patient developed oval nodule in lung. Clinically a metastasis. Following irradiation this disappeared	Clinically well 3 years 9 months. Chest still clear June, 1940
Risch 166817 (Fig. 5)	62 yr. ♂	Osteosarcoma parietal bone, 4 cm. in diameter	4200 r over 1 month	Chronic painless ulcer skull. Had "stroke" with right hemiplegia	Clinically free of active neoplasm 3 years 3 months
Garpiel 153498 (Fig. 6)	26 yr. ♀	Parosteal fibrosarcoma right femur with ossification involving most of shaft of femur	5300 r over 3 months. Coley's toxins	Tumor mass inactive; no increase in size since treatment	Clinically well. No evidence of active neoplasm 4 years 3 months

* Diagnosis established by biopsy in every case.
** Table brought up to date June, 1940.

to control a malignant process. Patients who presented clinical evidence of metastases when first seen and were therefore subjects for palliative therapy alone are not included. In all the cases cited below radical surgical removal was not feasible or when advised was not accepted by the patient. Cases in which a radical surgical procedure was performed are not considered, since it is felt that the results, good or bad, in such instances must be ascribed primarily to the operation.

The cases have been grouped into two classes, those in which a favorable response obtained, summarized in Table I, and those in which the patients have since died, summarized in Table II.

DISCUSSION

In all the above cases the factors of treat-

Table II

Patient Sex and Age			Tumor*	Estimated Tumor Dose and Length of Treatment	Survival Following Onset of Treatment
Eck 156138	♂	21 yr.	Ewing's sarcoma of sacrum	2340 r in 6 mo.	14 mo.
Reyn 76035	♀	24 yr.	Ewing's sarcoma sacroiliac region of pelvis	7300 r in 14 mo.	17 mo.
Goyette 166303	♂	42 yr.	Fibrosarcoma, right ischium	3000 r in 3 wk.	3 mo.
Dub 188916	♂	23 yr.	Ewing sarcoma of 2d and 3d of cervical vertebrae	8100 r in 9 mo.	Alive with local recurrence 16 mo.
Arcl 114796	♀	25 yr.	Ewing's sarcoma, pelvis	3700 r in 2 mo.	24 mo.
Yore 184961	♂	14 yr.	Ewing's sarcoma of ilium, left	2700 r in 1 mo.	4 mo.
Piz 157319	♂	29 yr.	Parosteal sarcoma, left ilium with ossification	4500 r over 11 mo.	15 mo.
Smut 178389	♂	54 yr.	Fibrosarcoma, left ilium	4300 r in 5 mo.	6 mo.
Volt 139259	♀	64 yr.	Osteosarcoma, left ilium	3600 r in 2 mo.	6 mo.
Kusera 77536	♂	51 yr.	Spindle cell sarcoma, left ischium and os	4880 mg-hr. radium and 2400 r in 6 wk.	12 mo.
List 99562	♂	14 yr.	Ewing's sarcoma, 7th thoracic vertebra	4000 r in 6 mo.	10 mo.
Stangerone 30008	♂	50 yr.	Osteosarcoma, 6th to 8th dorsal vertebrae	3000 r in 3 mo.	16 mo.
Schwartz 53160	♂	52 yr.	Osteosarcoma, right femur (also Paget's disease of bone)	3700 r in 14 mo.	19 mo.
Petuon 74714	♂	19 yr.	Ewing's sarcoma, right scapula	5100 r in 1½ mo.	12 mo.

* Diagnosis established by biopsy in every case.

ment were 200 kv., 25 ma., 0.5 to 1 mm. Cu and 1.0 mm. Al filter, 50 to 80 cm. focal skin distance, and an intensity of 30 to 42 r per minute (measured in air). The doses indicated represent the estimated total amount of radiation delivered into the tumor. The major portion of this was given at the onset of treatment over a period of forty to sixty days. The longer periods recorded signify that after the major portion of the treatment was given, smaller doses were added at later dates. In general, large fields were employed, with cross-fire where possible.

A review of the tables shows that no correlation was possible in this series between the favorable responses and histologic type of the neoplasms. The general impression

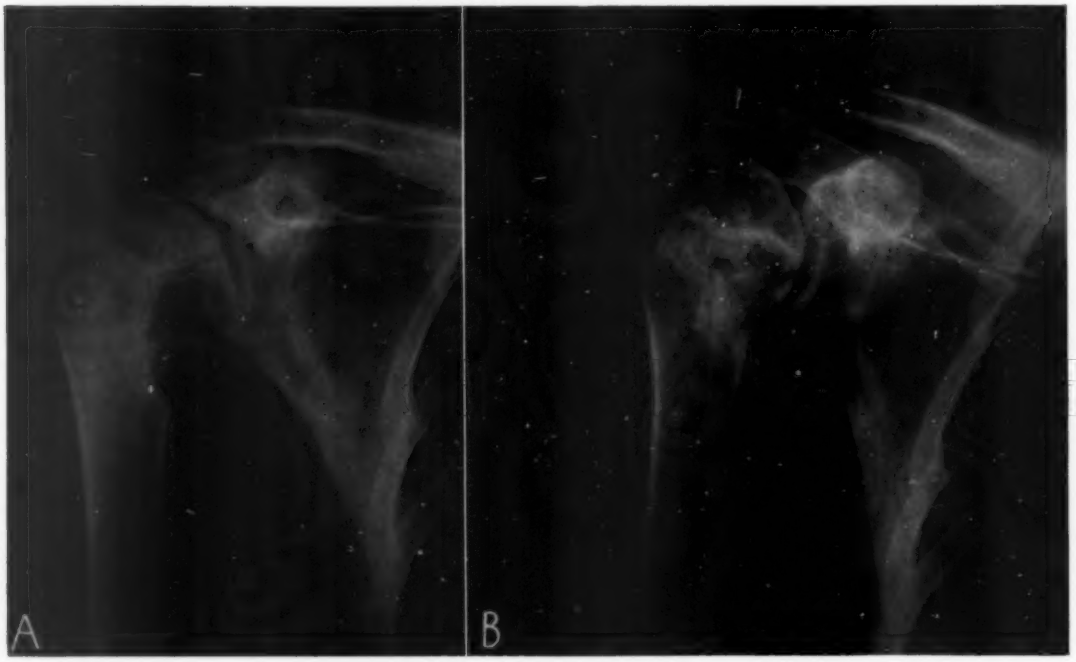

FIG. 2. (*Above*) *A*, chondrosarcoma of upper end of humerus. *B*, appearance of site of lesion five years after local curettage followed by 7,500 r to tumor. There has been extensive reossification in tumor site. Dense shadows in medullary cavity below site of lesion indicate possibly aseptic necrotic bone due to large amount of radiation that was received.

FIG. 3. (*Left*) *A*, large neoplasm about right acetabulum (fibrosarcoma). This roentgenogram was taken six months after roentgen therapy had been given. *B*, appearance of lesion three years after beginning treatment and two and a half years after curettage and additional roentgen therapy. The patient remains clinically well without evidence of distant metastases.

that Ewing's sarcoma is especially radiosensitive is based upon the observations that gross regressions of such neoplasms are not rarely observed following irradiation. That the ultimate "cure rate" of Ewing's sarcoma by irradiation is substantially higher than with other types of primary bone tumors remains, in our opinion, to be demonstrated.

In the above series of 20 cases, beneficial effects of irradiation were noted in 6 instances, or in 30 per cent. The latter does not refer to a "cure rate" since in some of these patients the neoplasm was not com-

pletely destroyed but rather was inactivated. The criterion for beneficial results was considered to be at least an approximate three year interval with no clinical manifestations of proliferating neoplasm. It is perhaps fair to state that such inactivity would not have occurred spontaneously. In 2 instances of the favorable results (cases Guld. and Dubsk.) a local surgical procedure was performed (curettage) but this was of such a nature that it was hardly regarded as adequate in itself to control a malignant process.

Fig. 4. *A*, diffuse mottling in right ala of sacrum due to Ewing's sarcoma. *B*, appearance two and a half years after receiving a tumor dose of 3,730 r. There has been no increase in bone destruction and three years after the above treatment the patient remains clinically well. Six months after treatment began roentgenograms of the chest revealed a rounded dense shadow in the midportion of the left lung which led to the roentgenographic diagnosis of metastasis. This disappeared following roentgen therapy to the region.

Fig. 5. *A*, photograph of patient with osteosarcoma of parietal bone producing a fungating mass. *B*, photograph of site of tumor two years after tumor dose of 4,200 r. A large indolent but painless ulceration persists from which small fragments of necrotic bone are extruded from time to time. The patient has suffered from a right hemiplegia but remains free from evidence of locally active neoplasm or of evidence of distant metastases (September, 1939).

The foregoing summary is the record of an experience in the radiation therapy of primary malignant skeletal neoplasms in patients who when first seen did not present the clinical picture of advanced cancer. From the results obtained it would appear that radiation therapy alone will benefit only a minority of primary skeletal sarcomas and that permanent destruction of them by such treatment as given at present will be even less frequently observed. These impressions conform to the generally

FIG. 6. *A*, parosteal or periosteal fibrosarcoma with ossification and calcification. *B*, appearance three years after tumor dose of 5,300 r and Coley's toxin. The mass has remained stationary in size and there is no evidence of distant metastases.

accepted views in regard to the radiosensitivity of primary bone tumors taken as a group.

In the group of 14 cases where a fatal outcome resulted, varying degrees of palliation, especially as to localized pain, were noted with only few exceptions. In this group the average survival was twelve months after beginning treatment; the longest individual survival was twenty-four months.

The satisfactory results obtained in cases Guld. and Dubsk. indicate to us at least that where a localized surgical removal may be accomplished, this should be performed in addition to the radiation therapy, even though in itself such a relatively conservative operation might not appear adequate to control the neoplasm. There is both clinical and experimental evidence to indicate that small and thin layers of tumor tissue are more easily destroyed by irradiation than are large dense masses of such tissue.

SUMMARY

A series of 20 patients with primary malignant skeletal neoplasms of various types, who did not present clinical evidence of advanced stages of the disease when first seen and in whom for one reason or another radical surgical removal was not performed, were treated by roentgen irradiation. In 6 instances (30 per cent of the series) beneficial effects of such treatment were noted, in that there was a survival of at least approximately three years without clinical evidence of extension of the disease. In 2 of the latter group there were also performed conservative surgical procedures.

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DISCUSSION

DR. H. DABNEY KERR, Iowa City, Iowa. It is a pleasure to be able to discuss a paper such as that presented by Drs. Brunschwig and Tschetter. I think they are to be congratulated on the happy results which they have obtained in this notoriously difficult field, the treatment of bone tumors. To me one of the most important points in this paper is the fact that their 20 cases were all proved histologically.

A great many men, ourselves among the group, treat bone tumors on roentgen diagnosis or impression alone, and any good result they might get would then be classed as a good palliation of a primary malignant bone tumor. We have come to take the point of view in our work that if any unproved case of a probable primary bone neoplasm lives for more than five years when treated only by irradiation, this is prima facie evidence that the patient did not have a primary malignant neoplasm of the bone. We have several instances in which this is the case, and recently in going over our material we automatically eliminated unproved cases which, when treated by irradiation alone, had lived five years or even three years.

To me that is one of the most significant

parts of this paper which we have all enjoyed, because only by painstaking attention to the type of neoplasm and to the proof of its malignancy can we hope to arrive at any real conception of what irradiation will do.

There was a time, eight or nine years ago, when our Surgical Department at our request, because of the poor results which they were getting from surgery, gave us all of the supposed primary bone neoplasms. We were permitted to keep these patients in our care as long as the disease did not progress. We have a group of 25 cases proved either by later operation or by later death from malignant disease, and of this group of 25, we have 3 proved cases living from six to eight years, but none of these cases was treated by irradiation alone. All 3 came to surgery, and it was because of our inability continually to influence these tumors favorably that we suggested to the surgeon that we give up our attempt to control them and that he operate on them.

Because of our experience even when doses larger than Dr. Brunschwig's were used, we now feel that in our hands irradiation alone in primary bone neoplasm is not justified, except in those cases, as has again been emphasized by Dr. Brunschwig, where the lesion is not operable because of its position, or when the patient refuses such procedure.

We have not had the results that Dr. Brunschwig has had and I should like to congratulate him on his results. Our own feeling, however, is that we must give the surgeon a real chance in curing these patients.

Dr. Brunschwig (closing). I should just like to add that we agree with Dr. Kerr that primary bone sarcoma is primarily a surgical disease, and that even though one might obtain good palliative results in a series of cases that does not mean that one should not attempt to remove these tumors surgically when they can be removed, and there is no evidence of metastasis. No tumor is surgically resistant, but there are many tumors that are radioresistant and radical removal should always be urged upon the patient first. However, the point I wished to emphasize in my presentation was that an extremely pessimistic attitude regarding the value of irradiation in benefiting cases of primary bone tumor is not justified.

OBSERVATIONS ON CIRCULATORY CHANGES IN BONE*

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IN considering the subject of circulatory changes in bone, it is obviously impossible to summarize changes found in each individual bone of the skeleton or in every clinical entity of circulatory disease. However, an attempt will be made to consider the effect of altered circulation in those areas of the skeleton which have a limited margin of safety to circulatory changes and which are accessible for pathological study. It is hoped that from these considerations some general principles may be established which will lead to a better understanding of the behavior of bone in the presence of altered circulation. Except for the rare instances of tumors arising from blood vessels, the relation of bone to circulation is one of growth, necrosis and of altered nutrition. Changes occurring in the head of the femur or in the carpal semilunar may be found anywhere in the skeleton although the clinical and pathological picture may be less sharply defined.

The normal physiological functioning and survival of body tissues and cells is dependent upon an adequate flow of intercellular fluid. This, in turn, is dependent upon an adequate blood supply of both the arterial and venous systems. In most parts of the body, Nature has provided liberal anastomoses between the various component parts of these vascular systems, and in so doing has provided a wide margin of safety to most tissues, enabling them to compensate for all but the most extensive interruption of the vascular flow. Those areas which are less liberally supplied with vascular anastomoses necessarily have lower factors of safety and become more vulnerable to the effects of vascular interruption.

When vascular anastomoses are widespread, as in congenital arteriovenous fistulae or in extensive nevus formation, tissue growth is accelerated. When the blood supply is insufficient because of impaired venous return, physiological processes are impaired, tissues degenerate both physiologically and structurally, producing the pathological picture of necrosis in all its stages. Similar changes are observed following trauma, over-exposure to roentgen rays and radium, and in some forms of chemical poisoning.

The significance of limited blood supply is revealed in the numerous vascular accidents seen in routine medical practice. Chronic or acute restriction of the coronary circulation of the heart results in a wide variety of pathological changes in the areas supplied. Fragmentation of the heart muscle fibers, hyaline degeneration, fibrosis, calcification, etc., are seen in unending degrees at autopsy and the evidence of altered physiology is seen in the living. The limited anastomosis of the coronary vessels has reduced the factor of safety to almost nil.

The restriction of circulation to the brain following embolic, thrombotic or other pathological process, results in the impairment of the physiological functions of the area involved. Local necrosis or softening is present in the brain substance. Because of limited anastomosis, the tissues of the lung periphery become vulnerable and infarction is common. Similar changes are seen in the liver, spleen, kidneys and mesentery or anywhere that the blood vessels simulate end-arteries. The areas of infarction of these tissues heal by fibrosis.

Obstruction of the venous return in the absence of free anastomosis may likewise result in degenerative changes in the involved tissue.

Bone must not be considered an inert substance, but one of the most specialized tissues of the body, consisting of active cells which respond promptly to the physiological demands upon the skeletal and

* Read at the Fortieth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 19–22, 1939.

hemopoietic systems. These cells are sensitive to nutritional and functional processes and differ in their reaction only because of the rigidity and stability of the rigid intercellular deposits of mineral salts. The response of the intercellular substance lags behind that of the cellular physiology to some degree because of its dense rigid character. Bone atrophy, sclerosis, and callus formation are common examples of this response. Bone is ideally constructed to withstand the chief functional demands upon it, that of resistance to compression as in weight bearing and resistance to traction as in muscle pull. Free transplants of tibia will be absorbed if placed in an environment free of compression strain but will survive when this strain is present.

The circulation of bone is sufficient to supply the normal variations of physiological processes, but often fails to respond to the extreme insults of trauma or infection.

Fig. 1. Aseptic necrosis (infarction) of femoral head.

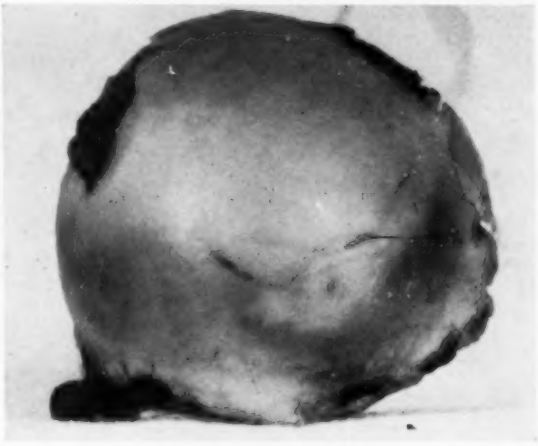

Fig. 2. Excised femoral head (Fig. 1). X indicates outline of sequestrated infarcted area.

The delayed union in the comminuted bumper fracture of the tibia or the extensive involvement of the shaft of the long bones in osteomyelitis are classical examples. Vascular anastomosis in bone is limited by two factors, first, the absence of large intercommunicating vascular channels and, secondly, the relative constriction of the existing channels by the rigid bone structure. When end-arteries are present, as at the metaphyseal side of the epiphyseal plate, infarction is common. Aseptic infarction is found in nutritional diseases such as scruvy and rickets and septic infarction with abscess formation in tuberculosis and other forms of bacteriemia.

A brief review of the embryology of the circulation of bone may be of interest.

Nutrient vessels enter the diaphysis and each end of the long bones. These areas are separated by the development of the epiphyseal plate which is not penetrated by blood vessels until it disappears on completion of growth. The epiphysis receives its nutrition from blood vessels which enter it at the epiphyseal line at which the capsule is originally attached. As the demands of muscle leverage and range of motion develop, migration of the capsular attachment occurs. This is most marked at the upper end of the femur where the capsule is attached along the lateral portion of the femoral neck distal to the epiphyseal line.

FIG. 3. Cut surface of excised femoral head showing infarcted area in center and to the right.

The blood vessels, however, persist in folds of synovial tissue extending to the epiphyseal line. That portion of the diaphysis which projects beyond the capsular attachment assumes many of the characteristics of the epiphysis, most important of which is the loss of osteogenetic function in the periosteum of these areas. This is seen in the total absence of subperiosteal callus in intracapsular fractures of the femoral neck.

During the course of the development of the head of the femur to comply with the demands of weight bearing and wide range of motion, the articular surface surrounds a considerable portion of the capsule isolating it to form the ligamentum teres. Included in this unique structure are varying numbers of blood vessels supplying the proximal portion of the femoral head. Incomplete inclusion of this portion of the capsule gives rise to the reflected ligament which is normal in reptiles. A similar migration of the triradiate articular surfaces is seen in the acetabulum. It is incomplete, however, as shown by the persistence of the incisura acetabuli and transverse ligament.

Contrary to the popular belief, the vascular supply afforded the head of the femur by the ligamentum teres is important. Kolodny, S. W. Chandler and Kreuscher, Wolcott and others have demonstrated the presence of vessels in sufficient number and size to make them potent factors in the nutrition of the central portion of the head of the femur. S. W. Chandler and Kreuscher examined 114 ligamenta teres from adults with an average age of forty-eight years. Eighty-six ligaments contained vessels varying from 0.2 to 1.5 mm. in diameter. Only four ligaments were relatively avascular. The others revealed small vessels or obliterating vessels.

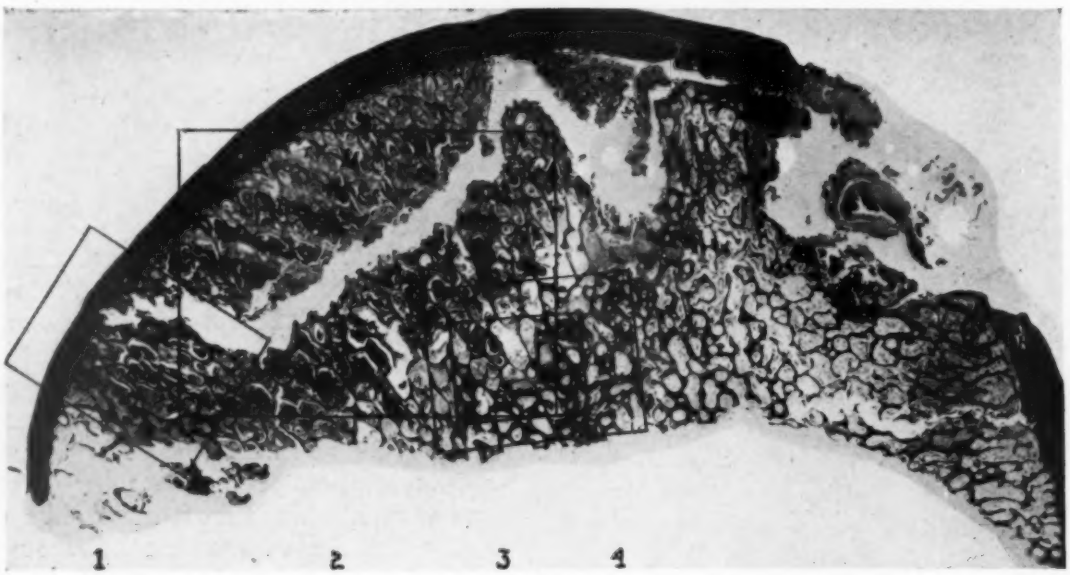

FIG. 4. Photomicrograph of median section of excised femoral head (Fig. 1).

The head of the femur, before fusion of the epiphysis, receives its blood supply through the branches of the cervical vessels which lie in the folds of reflected synovia along the femoral neck and from the vessels of the ligamentum teres. The recent observations of Wolcott indicate that this statement is probably incorrect. His study indicates that the blood supply coming to the femoral head through the ligamentum teres is insignificant or nil during childhood. However, after epiphyseal closure, vessels penetrate the ligament longitudinally and nourish a small area about the fovea centralis. When the origin of the ligamentum teres as mentioned above is recalled, such a development of blood supply would seem to follow that of the epiphysis other than the head of the femur. After fusion of the epiphysis at the conclusion of growth, small vessels of the femoral neck anastomose with those of the femoral head in increasing numbers. The venous supply of the femoral head closely follows that of the arterial. One factor influencing venous return, which has not been emphasized, is that of the potential negative atmospheric pressure within the hip joint. Such negative pressure preserves the patency of the veins. The positive pressure resulting from effusion within the joint capsule may well be a factor in the impairment of the circulation of the intercapsular portion of the femoral neck and head by damming the vascular return. The application of this principle in intracapsular fractures of the femoral neck and infections of the hip joint is obvious.

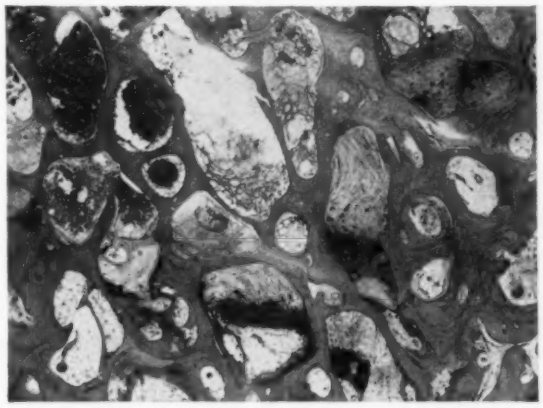

Fig. 5. Area 3 of Figure 4, showing line of demarcation of living (below) and necrotic bone (above). Note new bone formation along trabeculae in lower portion of section and absence of cells along trabeculae in upper portion of section.

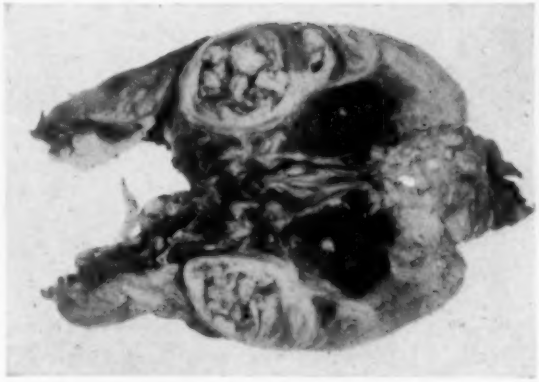

Fig. 6. Ligamentum teres (Fig. 1) halved by longitudinal section, showing cystic degeneration.

The reaction of the femoral head to complete and incomplete interruption of its blood supply is the same as in any area with limited anastomotic connections. The cellular element shows early alterations. Osteoblastic cells disappear from their position along the bone trabeculae which surround the marrow spaces. The marrow spaces are filled with a fine precipitate of necrotic material or later with fibrous tissue. The bony trabeculae gradually absorb and collapse under the pressure of weight bearing or muscle pull. These reactions

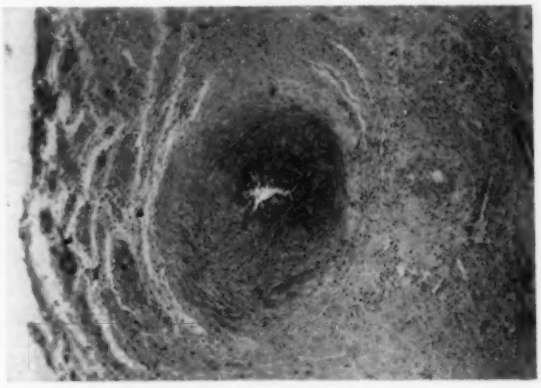

Fig. 7. Occluded nutrient arteries of Figure 6.

Fig. 8. Roentgenogram of bilateral aseptic necrosis of femoral heads. Necrosis is accompanied by reparative processes at articular margins.

may be distributed throughout the substance of the femoral head producing the appearance of cysts in the roentgenogram or they may be massive causing the femoral head to appear as a sequestrum with increase of density as shown in the roentgenogram. New bone slowly fills in about the trabeculae in those areas invaded by capillaries from adjacent viable areas.

Complete obliteration of the vessels of the ligamentum teres results in infarction of the area, near the fovea centralis, which is dependent upon it. Bone death occurs and the area involved separates from the adjacent viable tissue forming a sequestrum. Should the blood supply be only partially obliterated, the necrosis of bone may be incomplete and scattered throughout the femoral head combining zones of necrosis with areas of repair. As new sources of nutrition develop from adjacent areas an attempt at replacement of bone tissue occurs. If the immediate environment is vascular, this process is rapid and more complete; if avascular, repair is slow and limited. Phemister has given the term "creeping substitution" to this process of replacement of necrotic bone.

In the head of the femur, replacement of necrotic bone is slow and often incompiete. This leaves the head of the femur structurally weak and unable to withstand the strain of superimposed weight, and collapse follows.

Fig. 9. Excised femoral head (Fig. 8, right) showing marginal proliferation of cartilage and underlying bone.

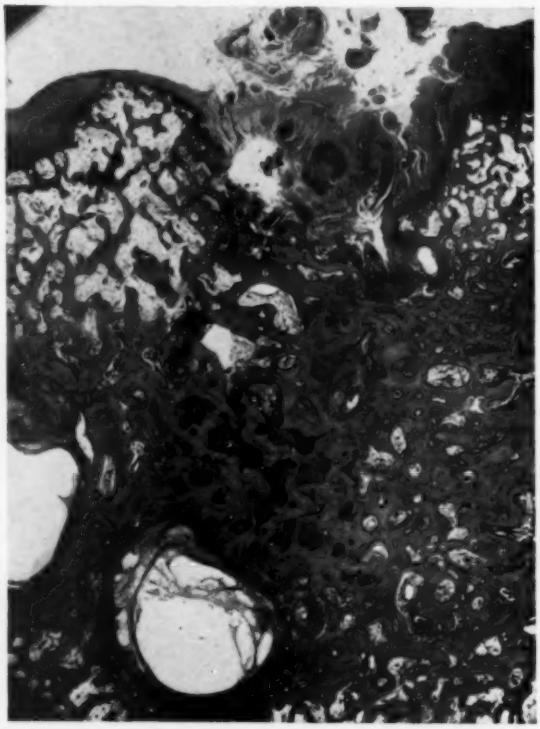

Fig. 10. Photomicrograph of section through fovea centralis showing areas of new bone as well as areas of necrosis.

In bone necrosis associated with infectious processes, sequestration or bone absorption occurs. The process of replacement does not take place except when the infection is of the lowest grade and when the circulation is adequate.

Aseptic necrosis of the head of the femur is of high incidence following intracapsular fractures of the femoral neck and probably accounts for many of the unsatisfactory re-

Fig. 11. New bone forming between layers of articular cartilage (above), extensive necrosis (below).

sults of treatment. If the anastomoses of the cancellous bone of the femoral neck, of the ligamentum teres and of the periosteal vessels are impaired necrosis follows. Similar changes follow tearing of the ligamentum teres in traumatic dislocation as well

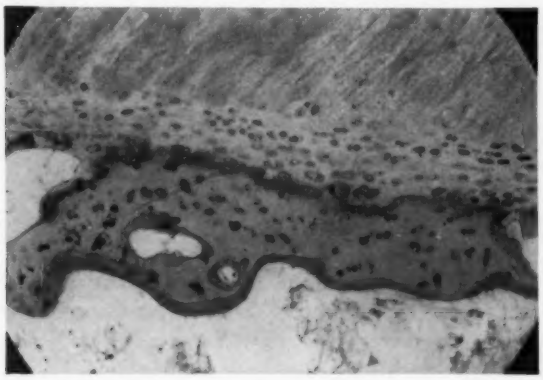

Fig. 12. Photomicrograph showing survival and regeneration of cartilage cells in presence of extensive aseptic necrosis of femoral head.

as in congenital dislocations of the hip. Trauma, acute or chronic, to the ligamentum teres without fracture or dislocation is sometimes seen. Embolic or thrombotic processes, involving the ligamentum teres, result in more or less complete necrosis of this area. Legg-Perthes' disease and air em-

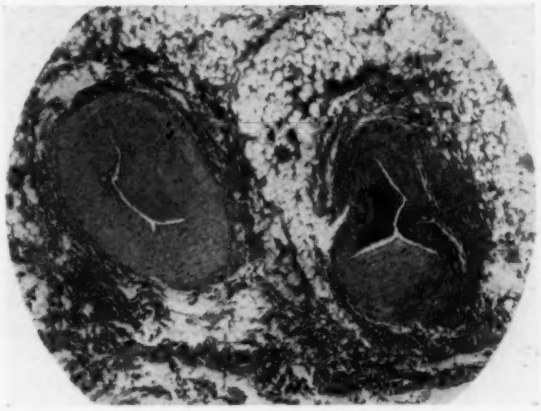

Fig. 13. Cross section of arteries of ligamentum teres (Fig. 8, right).

bolism in caisson disease, described recently, show similar changes in the femoral head.

Aseptic necrosis is encountered elsewhere in the skeleton in locations where vascular supply is limited. Kienböck's disease of the carpal semilunar bone, nonunion of fractures of the carpal scaphoid, Köhler's disease of the tarsal scaphoid and osteochondritis dissecans of the medial condyle of the femur and other entities show these pathological changes.

TREATMENT

The treatment of aseptic necrosis calls for prolonged protection from compression strain during the slow process of revascu-

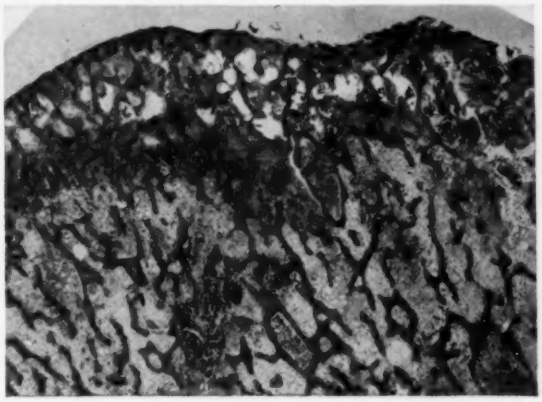

Fig. 14. Section of sequestrated femoral head in pathological dislocation in septic arthritis. Note complete aseptic necrosis of bone and disappearance of articular cartilage.

larization and bone replacement. The end-results of fractures of the femoral neck should not be evaluated until the effects of altered blood supply have passed; probably not for a four or five year period.

The high incidence of congenital anomalies of the circulatory system is recognized and a brief consideration of their relation to bone response will be attempted. The association of skeletal overgrowth with maldevelopment of the vascular system has been emphasized by many writers.

Alterations in the rate of the growth of bone may be due to the increased circulation of intercellular fluid or possibly to the increased temperatures which are found. Intercommunications between the larger vessels (arteriovenous fistulae) result in a distinct elevation of the oxygen tension of the blood of the venous system. All portions of the extremity involved develop at an accelerated rate of growth. This rate continues until growth ceases or compensatory mechanisms fail and gangrene supervenes. The observations of Ghormley and Horton have been most valuable in this connection. Such fistulae occur at any level and have been observed at the heart itself. The extremity affected shows an overgrowth of all elements and the surface of the skin shows a distinct elevation of temperature. The venous pressure is increased, and compensatory hypertrophy of the heart results. A similar short circuiting of arterial flow may occur as a result of dilatation of the capillary bed in extensive vascular nevus formation. Observations of cutaneous temperature in areas of nevus formation show that an elevation of 2° C. (3.6° F.) above the temperature of adjacent normal skin is not uncommon. Under these conditions growth is excessive. The faulty development of the vascular tree points to some factor active in the fourth week of embryonic life. When this factor continues over a longer period or develops somewhat later in embryonic life, distortion of the lymphatic system may complicate the picture. Arteriovenous fistulae, vascular nevi, hemangioma and lymphangioma may be present in the same person and serve as the basic factors in causing overgrowth of the extremity.

In closing, I wish to make a brief reference to post-traumatic acute bone atrophy (Sudeck's atrophy). This condition is of rather infrequent occurrence but when encountered presents a baffling problem. A minor injury may be followed by an extensive, rapidly developing atrophy of bone accompanied by signs of inflammation of the soft parts. The clinical picture is out of all proportion to the injury sustained. Infection is suggested by the soft tissue swelling and pain but the usual sequelae of infection are absent. Roentgenograms reveal a rapid, spotty demineralization of bone which may extend throughout the entire extremity. Blood chemistry and detailed studies of the vascular system are inconclusive. Remineralization slowly follows gradual resumption of function.

CONCLUSIONS

1. Bone is a highly specialized tissue dependent on an adequate blood supply for the preservation of its structural and physiological functions.

2. Because of its dense character, bone shows a definite lag in its response to associated pathology both in regard to degenerative changes as well as in its reparative processes.

DISCUSSION

Dr. Edwin W. Ryerson, Chicago. The importance of the changes in the circulation of the bones has not been very prominently put before our medical profession until in recent years. Years ago we realized that after fractures of the neck of the femur one was likely to see a degeneration of the femoral head, and Phemister first called our attention to the roentgen appearances which so regularly and so importantly showed the death of the head of the femur, which influences the treatment and prognosis enormously. It was some years later that we began to realize, as has been pointed out in Dr. Chandler's excellent paper, that dislocations of the head of the femur are sometimes followed by areas of necrosis at the ter-

minals of the blood supply through the artery of the ligamentum teres.

I have seen in the last few years 7 cases of uncomplicated dislocations of the head of the femur, which went along, after a competent reduction had been performed, for a year, sometimes only ten or eleven months, sometimes fourteen or fifteen months and then the patients began to complain of pain in the hip, and on roentgen examination an area of necrotic bone was visible at the fovea centralis. This condition a serious surgical problem.

It is possible that if we could keep the head of such a femur from any weight bearing or from any pressure, the creeping substitution of new bone-cells might reproduce the head, but it is extremely difficult to keep people at rest and to keep the head of the femur from pressure and from weight bearing for as long a period as would be necessary. Consequently the practical side of it is that it is better to excise these dead femoral heads and move the greater trochanter an inch or more lower down on the shaft of the femur, the Whitman reconstruction operation; and that has been done in most of the cases that we have seen in recent years.

Similarly with cases of death of the head of the femur after a fracture, that is probably the best solution of the problem. If the head is so dead that a bone graft will not revivify it and make it useful, it is better to remove it and to let the patient bear his weight on the rounded-off neck of the femur.

Legg-Perthes' disease is another interesting condition. We do not know the cause of it. We do know that there is an interruption in the circulation in the head of the femur and that plastic changes take place even with the best attempts at nonweight bearing. The other common condition seen in orthopedic practice is the osteochondritis dissecans of the lower end of the femur. König described it many years ago. A small area as big as the end of a finger becomes avascular, always on the medial condyle of the femur, and as time goes on it usually separates gradually from the rest of the condyle and becomes extruded into the joint as a loose body. These are the loose bodies that so many of us have seen floating around in the joint, and sometimes they are very difficult to find at operation because they are elusive. When we cut into the joint this "joint mouse" may not be where it showed in the roentgenogram, but anywhere else in the joint. That is another example of an aseptic necrosis following interruption of the circulation in the femur. It is probable that an injury is the cause of that particular condition, that the spine of the tibia is bumped hard against the medial condyle and produces a local area of necrosis.

Roentgenograms are of the greatest importance in determining what is to be done for these various conditions, the very familiar Kienböck's necrosis of the carpal semilunar, the os lunatum, and there are many other types of this curious and unsolved problem, such as Köhler's disease of the tarsal scaphoid, the navicular bone of the foot, and of the second or third metatarsal head. All of these conditions are due to an interruption of circulation, and in many of these cases, especially in children, we do not yet know the actual cause of this interruption.

I think this is an excellent paper because it means a great deal to both the roentgenologist and the orthopedic surgeon.

PREOPERATIVE IRRADIATION OF THE BREAST*

By WILLIAM E. HOWES, M.D., *Attending Radiation Therapist and*
HERMAN BOLKER, M.D., *Attending Pathologist*
Brooklyn Cancer Institute†
BROOKLYN, NEW YORK

THE technique of the surgical approach in the treatment of mammary carcinoma has changed little since the days of Halsted and Meyer. The prognosis has depended upon the extent of the growth; i.e., when the tumor is limited to the breast, the five year curability approaches 80 per cent; but when the axillary glands are involved, or other extensions have taken place, the percentage of curability is proportionately low and from conservative source has seldom surpassed 20 per cent.

In spite of the breast being in a part of the body which can be easily inspected and palpated, and in spite of all of the propaganda warning the public to report any abnormal growths or discharge, fully 50 per cent of all cases of breast cancer report to a physician only after glands are palpable in the axilla. The public has not been entirely responsible for this situation, as we have all examined women with a small primary tumor and extensive axillary metastases, who truthfully say that they have noticed the lump in the breast for only a very short period of time.

Certainly, then, with so large a percentage of advanced lesions, and with the lower five year curability rate in this group, the problem of treatment in breast carcinoma has not been solved. The addition of any other modality which will raise this curability rate should be seriously considered.

With these facts in mind, the attending physicians at the Brooklyn Cancer Institute agreed to submit a series of these more advanced cases to intensive preoperative roentgen therapy.

If large doses are to be given, such as would produce violent skin reactions, and other complications, as pleural pulmonitis, proof of the malignant character of the lesion should first be obtained, either by means of a small surgical incision or needle biopsy.

The pre-irradiation biopsy followed by roentgen therapy and finally by radical surgery has given us the opportunity to study the morphological changes which have been produced in the tissues, following such roentgen therapy. The purpose of this paper is to show these effects.

TECHNIQUE

Our irradiation technique is based upon the knowledge that the usual spread of breast carcinoma is through the lymphatics into the axilla, and thence to the subclavian and supraclavicular zones. On the other hand, extension into the bones, mediastinum, lungs or liver is apt to occur late, and it cannot be foreseen in what direction these more distant metastases may extend.

1. *Breast.* The entire breast is crossfired with parallel roentgen-ray beams; one portal is directed through the breast from its medial margin (Fig. 1), the other (Fig. 2) approaches the breast laterally and from behind. The path of the ray is directed so that the beam emerges through the opposite side of the breast and is not directed down into the lung bed. At times an additional portal to the breast from below is included. Such angles can only be accomplished, with safety to the patient, with shockproof apparatus. The size of the portal varies from 8×10 cm. to 10×15 cm. and includes the whole glandular element of the breast. Two hundred roentgens (measured in air) are delivered to each of these two portals for five to six days a week. The total skin dose is limited not to exceed 6,000 r, calculating the emergent beams,

* Read at the Twenty-fourth Annual Meeting, American Radium Society, St. Louis, Mo., May 15–16, 1939.
† Dr. Ira I. Kaplan, Director, Division of Cancer, Department of Hospitals, City of New York.

the entering beam being measured in air. The other factors used are: 40 to 50 cm. skin-target distance, 200 kv., filtration 2 mm. copper and 1 mm. aluminum, half-value layer 1.90 mm. copper, approximately 20 r per minute.

2. *Supraclavicular.* The supraclavicular area is next crossfired (Figs. 3 and 4) through an anterior and posterior portal, usually 8×10 cm. in diameter. The lower border of this portal should extend below the clavicle to include the course of the subclavian vessels and their lymphatics. The same technical factors are used as above.

3. *Axilla.* The axillary portals measure 8×10 cm. or 10×12 cm. and may be used last, as the skin reaction in both the breast and supraclavicular areas is by this time distinctly visible and thus the danger of overlapping or allowing a ribbon-like band of unirradiated tissue to remain is minimized. Again, each individual portal in the

Fig. 1. Anterior oblique exposure to the breast; patient supine.

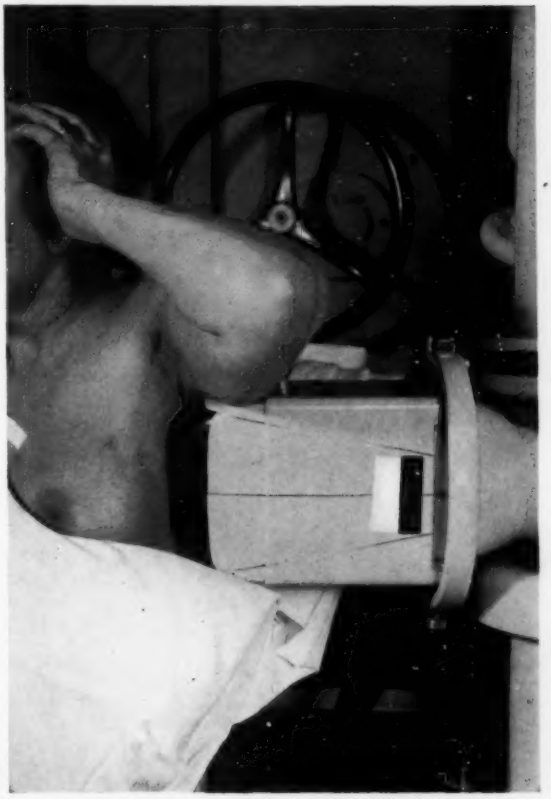

Fig. 2. Posterior oblique exposure to the breast; patient sitting.

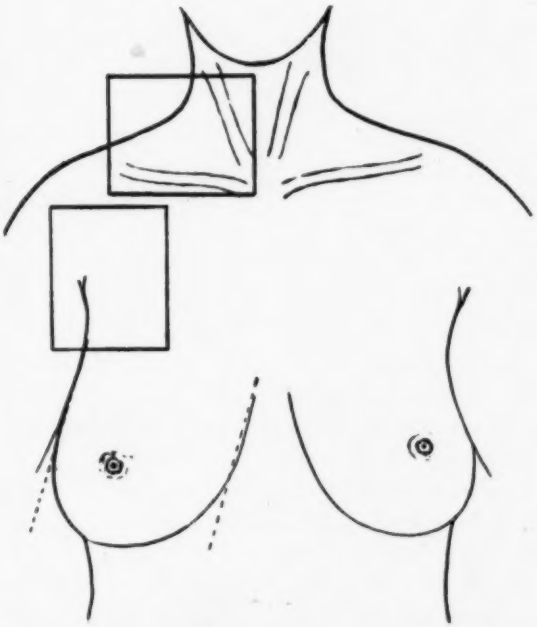

Fig. 3. Schematic drawing showing supraclavicular, axillary and breast portals.

axilla is seldom given over 2,800 r (measured in air), because the skin surface within the axilla is moist and subject to chafing and thereby somewhat more sensitive to the roentgen rays.

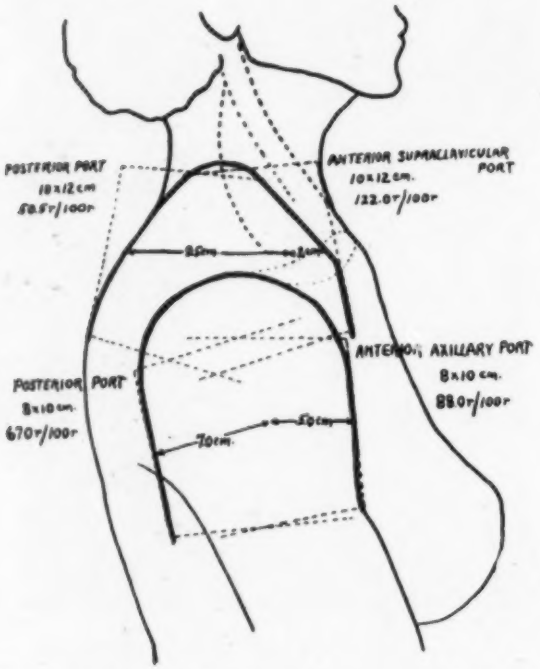

FIG. 4. Schematic drawing showing supraclavicular and axillary portals.

4. *Alternate Combination.* In the treatment of a few individuals we have combined the supraclavicular and axillary portals (Figs. 2 and 3) into one anterior and one posterior portal, usually 8×15 cm. to 8×20 cm. The larger size of the portal will of course increase the amount of penetration and will add to the total of the emergent beam. The danger in combining these two areas lies in the possibility of not reaching the nodes low down in the axilla and in over-irradiating the pulmonary apices. Such a combination, however, shortens the interval of treatment.

The diameter of the breast is carefully measured as is the anteroposterior diameter of the axilla and supraclavicular regions. These measurements are drawn out accurately on foolscap. The approximate site of the tumor is marked and an accurate determination is made from depth dose charts of the amount of radiation to reach the tumor, the supraclavicular fossa and the center of the axilla. Calculation of the emergent beam is a safeguard against over-irradiation to any single skin area.

Such a series of treatments requires seven to twelve weeks to complete and the skin reaction in the axilla and other parts is at its height ten days following the last dose. All of the reaction and re-epithelialization is completed six weeks to two months following the treatments. After a two to three month interval, radical mastectomy follows.

The final determination of the efficacy of this procedure is derived from a three to five year end-result. As the time interval in this series has been too short and our series of cases limited in number, no tabulation as to our end-results has as yet been prepared.

CLINICAL RESPONSE

The tumor will often shrink to a small percentage of its original size and metastatic glands in the axilla have been similarly influenced. On the other hand, we have had several failures in reducing the size of the original growth and in 2 instances the mass increased in size during or immediately following radiation therapy. The reduction in size of the tumor often produces an excellent psychological reaction. We have had 3 cases, however, who refused operation following this initial response to irradiation. One has since died of liver metastases.

COMPLICATIONS

Finally, complications which may arise from prolonged and intensive irradiation must be considered. The roentgen-ray dose has been carefully built up to closely approach the skin tolerance and most careful supervision must be maintained not to overstep this limit.

Radiation sickness is seldom experienced in the breast cases, as most of the radiation is confined to a fairly local area. Emphasis should be placed on diet, fresh air and proper elimination.

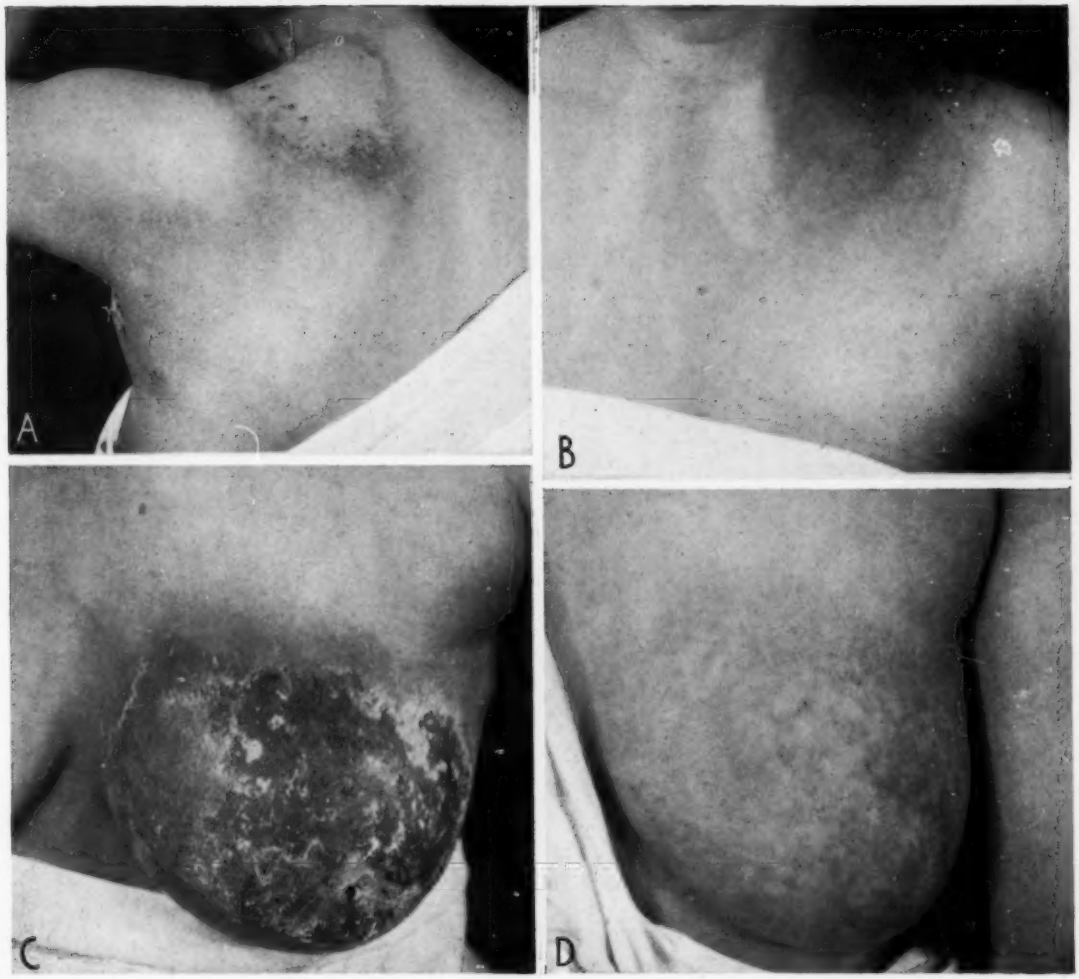

Fig. 5. Showing skin reaction. *A*, posterior; *B*, anterior; *C*, breast; *D*, end-result.

Infection plus carcinoma makes the case increasingly difficult to handle by either surgery or irradiation. Instituting irradiation with a comparatively small dose of from 50 to 100 r, the dose can be gradually increased. The infection is often localized and, following drainage, further intensive irradiation can be carried through.

A diagnosis of post-irradiation pleural pulmonitis was made in 2 cases. One had had most extensive irradiation both pre- and postoperatively, which included treatment to the mediastinum. Her symptoms and the appearance of the roentgenograms were typical of pulmonary fibrosis. No autopsy was obtained.

Several of these cases were autopsied and special study was made of the condition of the pleura and lung just beneath the breast. No demonstrable pleural thickening or pulmonary fibrosis was found except where the area had been invaded by carcinoma.

PATHOLOGY

Changes attributable to irradiation are found in the tumor, tumor bed, blood vessels, skin, remaining parenchyma and regional lymph nodes.

1. *Gross.* In the gross, the tumor is usually smaller and often difficult to recognize. It is grayish white and homogeneous in appearance. Occasional small gelatinous areas are found. The yellow streaks commonly seen in the unirradiated tumor are

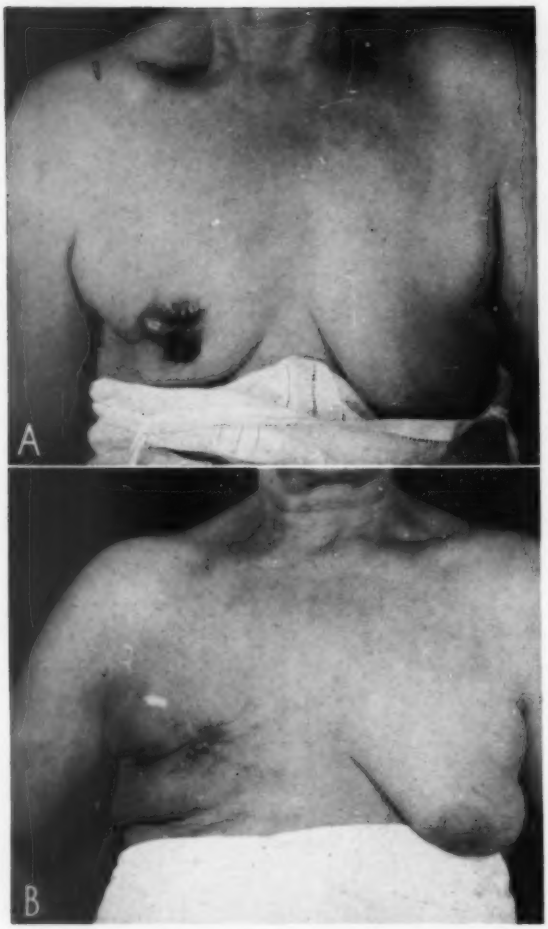

Fig. 6. Showing appearance of breast *A*, before irradiation; *B*, after irradiation.

absent or vaguely definable. The mass is of rubbery rather than gritty consistency and usually merges with the surrounding fat rather than showing a sharp line of demarcation.

2. *Microscopic.* The tumor cells are found singly, in small groups or rows, often widely separated by fibrous tissue. A glandular outline is rarely preserved. Both cytoplasm and nuclei are affected, the changes being of a lytic nature. The cytoplasm is scant and often shows no definable boundaries. The nuclei are either pale and swollen, with nucleoli uncommon, or hyperchromatic, shrunken or bizarre in outline. Mitotic figures are rarely found even in tumors which showed them in large numbers before irradiation.

The tumor bed consists of increased fibrous tissue, hyalin in type, and poorly cellular. Areas of myoxmatous change and calcification may be present. The fibrous masses are occasionally in lobular arrangement, suggesting complete replacement of a previous large neoplastic area. Leukocytic infiltration is scant (in our sections) and chiefly of the lymphocytic variety.

The blood vessels show thickening of their walls and occasional thrombosis with occlusion of the lumen.

The skin in the irradiated areas shows an atrophy of the epidermis, homogeneity of the underlying connective tissue, telangiectasia, inflammatory cellular infiltration and increased number of chromatophores.

In the remaining non-neoplastic parenchyma, the effect on the duct lining cells is similar to but less marked than on the tumor cells. The nuclei are shrunken and pyknotic and there is commonly a periductal lymphocytic infiltration.

The axillary lymph nodes often showed neoplastic involvement and changes attributable to irradiation were usually

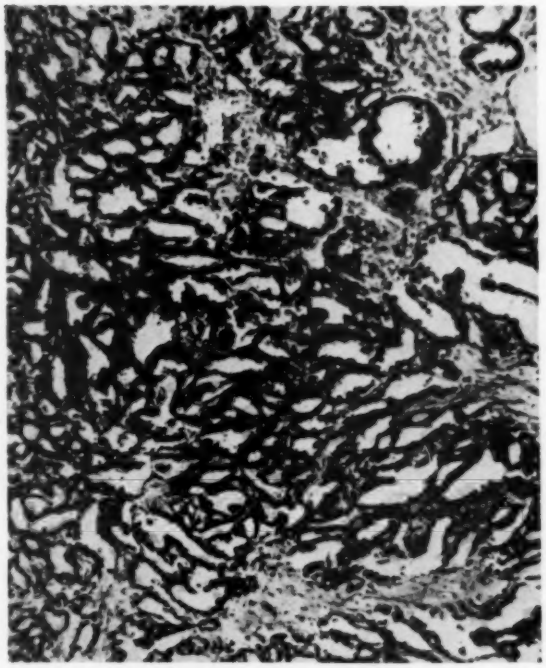

Fig. 7. Photomicrograph of section of breast; pre-irradiation biopsy.

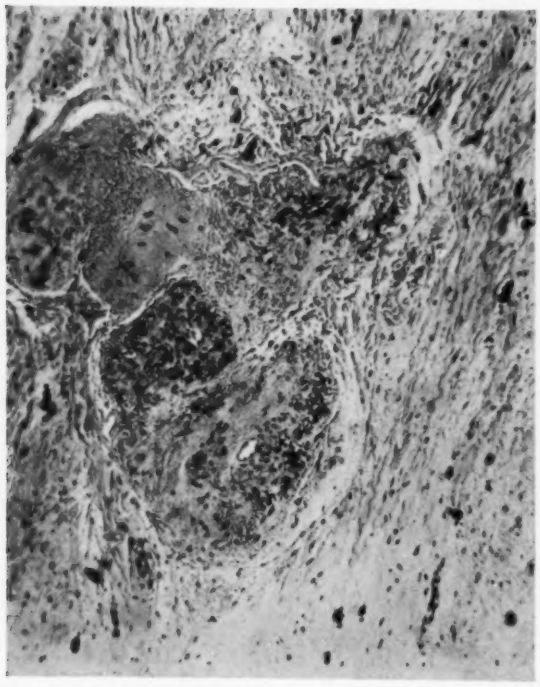

Fig. 8. Photomicrograph of section of breast showing post-irradiation cell degeneration.

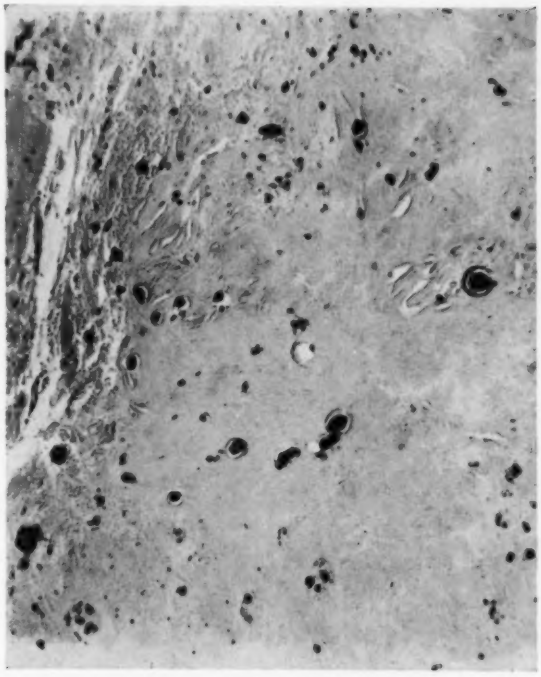

Fig. 9. Photomicrograph of section of breast showing post-irradiation terminal fibrosis and calcification.

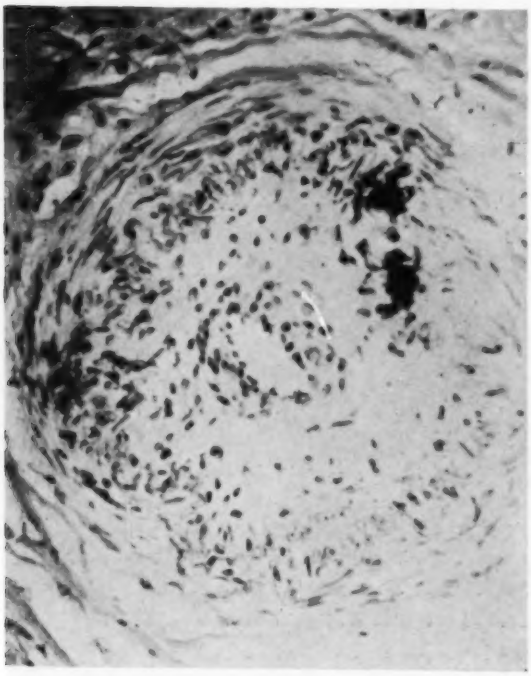

Fig. 10. Photomicrograph of section of breast after irradiation showing artery with subintimal thickening.

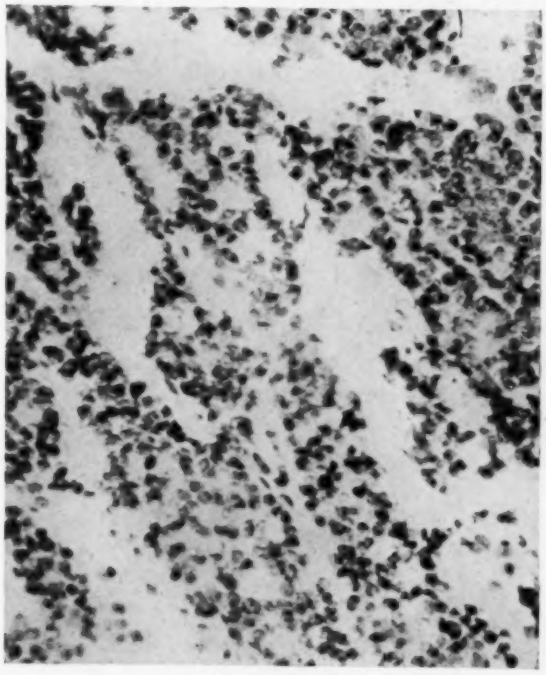

Fig. 11. Photomicrograph of section of axillary lymph node taken after irradiation.

slight, even in cases where the primary mammary lesion showed marked changes. Large groups of cells retain definite boundaries, many nuclei remain vesicular with demonstrable nucleoli. An occasional mitotic figure can be demonstrated. The fibrotic reaction is much less marked. The tumor cells in the nodes after irradiation often differ little in appearance from those of the original biopsy. The interval between irradiation and surgery was shortest in this region, which may be a factor in this lack of demonstrable irradiation effect.

Figures 6–10 show the appearance of a case in this series before and after radiation therapy, with photomicrographs illustrating the pre-irradiation appearance and post-irradiation effect.

SUMMARY

1. Statistics of large surgical clinics clearly indicate the inadequacy of the surgical approach in the treatment of the more advanced cases of carcinoma of the breast.

2. Some surgeons and radiologists have turned to preoperative roentgen therapy as a possible means of raising the curability percentage.

3. The technique of such preoperative therapy as is now being practiced at the Brooklyn Cancer Institute is outlined.

4. Complications arising from such treatment and their antidotes are discussed.

5. Comparison with pre-irradiation biopsy has permitted observation on the histology of irradiation effect following such a cycle of roentgen treatments.

DISCUSSION

DR. H. H. JAMES, Butte, Montana. I will make a few general remarks about irradiation of cancer of the breast.

Fundamental in the surgical treatment of malignant neoplasm is the widest possible removal of the primary growth together with its regional metastasis. The standardized radical operation for cancer of the breast may be said to date from the publication in 1894 by William Halsted of his method, and more recently modified to a still wider dissection by Sampson Handley of London.

While statistics accumulated in the course of the past quarter of a century showed some improvement, they were on the whole disappointing. Surgeons and radiologists therefore sought to improve their results by recourse to irradiation. Various combinations have been utilized:

1. Radical operation combined with preoperative irradiation, post-operative irradiation, or both.
2. Incomplete surgical procedure followed by irradiation.
3. Irradiation alone.

The literature, comprising American, English and European, contains numerous references to statistical comparisons between the results of surgery alone, and those of surgery and irradiation, with conclusions that indicate the merits of combined surgery and irradiation because of an increase in the percentage of cures of from 5 to 15 per cent.

It is my opinion that the decision as to the merits of either pre- or postoperative irradiation or irradiation alone on the basis of statistical evidence is dangerous, as our inability to control various factors such as the extent of the disease, the degree of malignancy and the efficiency of the surgical and irradiation procedures in large series of cases, renders it impossible to draw reliable and accurate conclusions from a comparison of one group of cases with another.

Variations in the relative proportion of favorable and unfavorable cases more than any other factor account for the extreme differences in end-results reported from surgical clinics in this country and abroad based upon tabulations of five year survivals. Before statistical analyses of the results from different clinics or for different forms of treatment can be compared, there must be some method of arriving at an equalization of the relative proportion of early and late cases treated.

It is also important to appreciate in this connection that whereas the surgical treatment of mammary cancer has been standardized for some time, the radiation treatment of this disease is undergoing constant change.

The last few years have witnessed the most rapid strides in radiotherapy and many of the results of these newer methods are not yet available. However, experience is gradually ac-

cumulating upon the ability of irradiation alone to cure mammary cancer.

The extensive use of radium in the treatment of operable cancer of the breast has been carried out, notably by Keynes of London. He believes from his own experience that the results of radium are superior to those of surgery in the treatment of operable mammary cancer.

In order to acquire equitable statistics, patients with suspected cancer of the breast should be very carefully studied before the course of treatment is decided upon. This study should include complete history, physical examination and roentgen examination of the skull, chest, spine and pelvis.

Following this study, the patients should be separated into two classes: (*a*) those with a chance of cure; (*b*) those without a chance of cure. The former should undergo radical operation with irradiation either before, after, or both; or treated by irradiation alone. The patients classed as incurable should be given powerful doses of radiation and no surgery.

All women who have not passed the menopause should be sterilized by irradiation.

If this procedure is carried out routinely, we will soon have statistics for comparison.

It is my personal opinion that the ultimate success of the present efforts to replace surgical removal of the breast by irradiation remains for the future to determine, and until the evidence is more abundant the radical surgical removal of the breast, combined with irradiation, should remain the procedure of choice in all breast carcinomata which are operable.

Dr. Frederick W. O'Brien, Boston. I would like to ask Dr. Howes if he thinks a case that is surgically inoperable is ever made operable by roentgen therapy. I don't mean technically operable but one that should be operated upon. Has he any statistics as to bone metastasis following cases presumably made operable by roentgen irradiation?

Dr. Orville N. Meland, Los Angeles, Calif. I would like to ask Dr. Howes a question with reference to biopsies. He speaks about doing needle biopsy and open biopsy. When he does an open biopsy, how long after the biopsy is done does he start his treatment? And does he ever have any breaking down of his wound afterward?

Dr. A. W. Oughterson, New Haven, Conn. It has been shown experimentally that spontaneous tumors in mice seem to have a correlation between the histology and the response of the tumor to radium or roentgen radiation. I would like to know if Dr. Howes has been able to see any such correlation in these cases.

Dr. Maurice Lenz, New York City. I would like to ask Dr. Howes whether he draws any conclusions from this very beautiful demonstration of microscopic irradiation changes. I ask this advisedly because at the Presbyterian Hospital we have given as much as 2,000 roentgens in air with 200 kv., 1 mm. Cu, to each of four 8×4 cm. fields, crossfiring the breast, and in spite of that have found actively growing cancer cells at the time the mastectomy specimen was examined. Mastectomy was done as long as two or three months after irradiation had been stopped. I want to know whether he draws any definite conclusions as to the indications for roentgen therapy in operable cancer of the breast.

Mrs. Edith H. Quimby, New York City. I would like to answer Dr. Oughterson's question, and also that of Dr. Lenz.

Some two or three years ago we made a survey of more than one hundred cases of cancer of the breast treated by intensive roentgen irradiation and subsequently removed surgically. Dr. Adair reported on this work at the Fifth International Congress of Radiology in 1937.

As far as the types of disease were concerned, there appeared to be no systematic difference in the response to irradiation. We obtained good results in some cases of all types and poor results in some of all types. We tried to correlate actual tumor dose of radiation and tumor response, and then see whether the majority of cases that reacted favorably belonged to certain types of disease, and whether those which received little benefit belonged to others. We could make no such segregation.

As far as Dr. Lenz's question is concerned, the same thing holds. In all these cases Dr. Fred Stewart studied in great detail the entire tissue which had been removed at operation, and determined the degree of radiation effect. Some of the cases in which the tumor had received more than six erythema doses still showed viable cancer cells, while a few which had received less than two erythema doses showed no cancer, although of course in general the percentage of complete disappearance of disease was greater the larger the tumor doses.

Dr. W. H. Wehr, Buffalo, N. Y. In the clinic of the State Institute for Malignant Dis-

ease in Buffalo, naturally the technique of irradiation in breast carcinoma has varied over a period of years. Dr. Schreiner years ago gave 40 per cent of the erythema dose and the following day did a radical mastectomy. As soon as the wound healed, a complete course of irradiation was given and this seemed to increase the percentage of cures about 5 per cent as compared to pure surgical statistics.

In more recent years, protracted treatments have been given over longer periods of time, using a single field and later multiple fields up to four,—in the majority of instances three fields were used; the medial field covering the breast proper, the second the breast and axilla, and the third field the supraclavicular region.

In most instances up to 250 r were given to one field daily and in some instances to two fields, the total dose being about 2,000 to 2,400 r, and at times 2,800 r.

In a good many of the Group 1 cases, the so-called operable group, and the borderline cases, those with axillary metastasis, radical mastectomy has been done two to three months later. While in some cases there has been complete sterilization, i.e., no evidence of carcinoma on microscopic examination, the percentage has not exceeded 10. As far as those with axillary metastases are concerned, the percentage of cases sterilized is even lower than that.

Mrs. Quimby has brought out that unquestionably there are definite changes following irradiation—certain tumor cells showing fragmentation and the other signs that would be expected, such as increase in fibrous tissue, etc. There is, however, no rhyme or reason to the response.

We have treated a good many cases with the large radium pack, 6 cm. distance, one or more fields to the breast and axilla, and this dose has been carried up to about 5,000 or 6,000 r. The dose in the tumor, as far as we are able to calculate, was about 4,000 r or more.

A specimen was obtained by aspiration biopsy in all of these cases before treatment. Nothing could be ascertained, either from the pathology, or from the method of treatment, whether one or more fields were used, or how the dose was fractionated, why some of the tumors disappeared and the radiation changes were marked, while in others no effect was noticed.

DR. CHARLES L. MARTIN, Dallas, Texas. I hope Dr. Howes will be good enough to again give us his daily dose and total dose to each area in his closing discussion. His doses as I understood them are above those which I have been able to give over the breast without producing irreparable damage in the subcutaneous fat.

DR. HOWES (closing). I appreciate the discussion; it shows the intense interest in this subject.

In the first place, I think that we are still feeling our way in the treatment of breast carcinoma. It is my impression that in the cases heretofore treated with preoperative irradiation the dosage has been too low and this has led to the conclusion among surgeons and radiologists that breast cancer is not amenable to roentgen irradiation. I have heard men of outstanding authority as radiologists condemn roentgen therapy to the breast. They condemn irradiation because they attempted treatment with massive doses such as were given years ago with no result. They possibly do not appreciate the change in our present technique, and with this change the results should be re-evaluated.

The technique of using suberythema daily doses, increased filtration, crossfire, etc., as has given such excellent results with carcinoma of the larynx, can also, I feel, be applied in treatment of breast lesions.

With regard to the pathological types, do I believe that any particular type is more radiosensitive than another? Some types which the pathologist felt should respond were most disappointing; on the other hand, some scirrhous carcinomas that were so hard that they could not be needle biopsied and had to be surgically biopsied have responded. One would not expect this type to be affected and still it has.

One nurse in our own institution had this particular type of scirrhous lesion. She is fortunately working with me and I am able to see her daily. She has now gone two years with no evidence of any recurrence. Because of this remarkable response to irradiation, Dr. Frank Adair suggested that her breast be not removed. Therefore, we have only the pre-irradiation biopsy in this case. Credit is due Dr. Adair since it is his work which aroused my interest in preoperative irradiation of the breast.

With regard to the needle and surgical biopsy, we have irradiated the patient on the next day following biopsy. I would consider a 2 inch incision sufficient for a surgical biopsy in the average breast carcinoma. I will say that the

area of incision may break down with definite ulceration but it has always healed.

With regard to the dosage, I give a total of 200 r in air per day to two areas. Very occasionally I have added a third area but that area has never received over 100 r in air daily. This treatment is given five to six days a week.

With bulkier breasts there is more secondary irradiation and with the fat they are less tolerant to irradiation, but I have been able to build up the total dose in nearly all my breast cases to 2,800 r in air to two portals—excluding the third portal—without any breakdown. This experience includes more than this group of 50 cases. This is the only group, however, that has had post-irradiation surgery. Two cases broke down when the dose was increased to 4,000 r, and the upper limit of safety appears to be 3,000 r in air, not including the exit dose.

The axilla will stand as much as the breast but since it is a moist contiguous surface, the patients complain very bitterly of the radiation reaction. The total dosage here, therefore, has been limited to 2,800 r in air per area.

The supraclavicular area will stand 3,000 r in air to two portals and here again it is an 8×10 cm. or 10×12 cm. area, depending upon the size of the individual. The areas must not overlap. On the slide you see that the portals to the breast were kept low so that they would not overlap the axillary areas. This minimizes the danger of tissue necrosis and allows the skin tolerance dose to be built up.

As to results, I have had 2 cases in another institution where the pathologist found no tumor, only shadow cells, so to speak. It is most essential for your own protection to have a biopsy before any type of therapy is instituted as we all know that occasionally benign lesions will simulate malignancy.

It is well known that irradiation in itself may not destroy the cell but may destroy its ability to multiply and therefore limit its metastasizing tendencies.

Dr. O'Brien: How many cases do you make operable?

Dr. Howes: We have had several cases which the surgeons deemed inoperable. At the time we started this irradiation approximately 5 per cent have since been accepted as operable. This includes a small percentage where the lesion is fixed to the chest wall, and following irradiation, it has become mobile.

Mrs. Quimby: Did you say how long you waited after the irradiation?

Dr. Howes: Two to three months.

REGRESSION OF CARCINOMA OF THE BREAST FOLLOWING ARTIFICIAL MENOPAUSE

A CASE REPORT*

By VINCENT W. ARCHER, B.S., M.D., *and* GEORGE COOPER, JR., B.A., M.D.
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BECAUSE of the current attention to a possible connection between the function of the ductless glands and at least the rate of growth and spread of carcinoma of the breast, the pertinent data in an interesting case are presented below. The course of this patient's disease was such that a full year intervened between artificial sterilization and institution of local roentgen therapy. During this period, a highly malignant and rapidly spreading carcinoma was observed not only to be held in check but to regress to an amazing degree, either because of or coincidental with cessation of ovarian function.

A housewife, aged thirty, was seen in the University Hospital July 11, 1938, complaining of a lump about the left clavicle.

Past History. While nursing her only child three years before, an abscess had developed in the left breast which twice required incision and drainage, then healed completely. During the past winter she had spit up small amounts of blood while suffering from a sore throat.

Present Illness. Three months before admission, she noticed a small, hard lump above the left clavicle. It was tender and grew slowly to the size of a hazelnut. She became very nervous and weak, spending a large part of her time in bed. Three weeks before admission, she consulted her physician. He removed the lump. One week later another mass was noted over the left pectoral muscle, following which she was referred to the University Hospital.

Physical Examination. The patient was a well developed, moderately obese young woman, apparently in the best of health. Above the left clavicle was found a recently healed surgical scar 10 cm. in length. Beneath this was an area of stony hard infiltration. Over the outer portion of the left pectoral muscle, there was a hard, lobulated, freely movable mass about 5 cm. in diameter. The breasts were symmetrical, the nipples normal. The left breast showed definite venous congestion and a 5 cm. radial scar in the horizontal axis on the lateral surface. Below the nipple in the breast substance was a hard, fairly sharply outlined mass about 3.5 cm. in diameter. This was not attached to the chest wall, skin or nipple. There was a hard, movable mass 2.5 cm. in diameter in the left axilla.

An attempt was made to aspirate the breast tumor but the tissue was so hard that material sufficient for a pathological opinion was not obtained. A roentgenogram of the chest revealed a clearly defined, round, soft tissue shadow 1.5 cm. in diameter in the left lung field under the third interspace, interpreted as metastasis. Slides prepared from the excised supraclavicular node were reported as showing the sections "composed almost entirely of highly malignant tumor cells, growing in thick, irregular sheets, only occasionally assuming an alveolar form. The cells varied enormously in size, shape and staining. There were many mitoses. Only a few lymphocytes were left. *Diagnosis:* Highly malignant carcinoma metastatic to lymph node. In view of the clinical findings, it seems most likely that this represents a metastasis from the breast tumor, but pathologically it is impossible to be positive of the origin of these cells. There is nothing distinctive of either adeno- or epidermoid carcinoma to be seen."

On the basis of the above findings, a clinical diagnosis of carcinoma of the breast was made. Because of the presence of the lung metastasis, it was felt that the patient should be sterilized at once and local roentgen therapy reserved for the period of skin involvement. Starting July 25, 1938, the patient was given in two weeks a total dose of 4,800 r over the ovaries, using four skin portals, a daily dose of 400 r, and the following technical factors: 200 kv., 25 ma., 0.5 mm. Cu plus 1 mm. Al filtration, 50 cm. distance.

Eight weeks later (Oct. 3, 1938) the patient returned for examination. There had been one intervening period, but she was gaining weight

* From the Department of Roentgenology, University of Virginia Hospital.

and experiencing definite menopausal symptoms. Otherwise, she felt much better than she had since onset of her illness. Physical examination revealed complete disappearance of the left supraclavicular infiltration. The site of the tumor over the left pectoral muscle was marked only by vaguely defined, localized infiltration. The left breast was entirely normal except for slight venous engorgement. The axillary mass was unchanged.

Six weeks later (Nov. 10, 1938) there had been no menstruation. The only clinical evidence of tumor was the axillary mass which remained unaffected. A roentgenogram of the chest showed no change in the size or appearance of the lung metastasis.

This condition continued until one year (August, 1939) after the roentgen sterilization. At this time a tender nodule was found in the outer portion of the left infraclavicular region, so tender that infection was considered. She was told to return in two weeks for a check up. On return the infraclavicular node had definitely grown, measuring 1 cm. in diameter. The axillary and lung metastases remained quiescent. Roentgen therapy to the axilla, infra- and supraclavicular areas was advised. In the next two weeks 1,400 r was given to the axilla; 1,000 r was given to the entire clavicular region, with an additional 1,000 r to a small area including the infraclavicular node. A daily dose of 200 to 400 r was administered with the following technical factors: 200 kv., 24 ma., 50 cm. distance and a filtration equivalent to 2 mm. of copper.

Six weeks later there was no clinical evidence of tumor except in the lung. This metastasis has remained stationary. To date (March 1, 1940) there has been no change in this patient's condition.

ETIOLOGICAL FACTORS IN SOME FORMS OF CANCER*

By DANIEL THOMAS QUIGLEY, M.D.
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IN A FORMER paper before this Society four years ago in Cleveland, I called attention to the fact that patients who were undergoing radiation treatment attained results in some degree in relation to the state of nutrition of the individual. In cases of local epithelial neoplasms which are ordinarily cured by irradiation it was shown that there was a better outcome as to cure and freedom from recurrence in the well nourished patients. From a group of 2,707 patients included in that report, we deduced that the state of nutrition of the individual has much to do with the chances for cure and that it also has something to do with the person acquiring the disease. The connection seemed to be through the interposition of various forms of chronic low grade infections engrafted in areas subjected to local trauma which was of such a nature as to carry repeated insults to the tissues. It was shown that the repeated insults to tissue interfered with the epithelial wall of protection allowing the ingress of microorganisms which acted as cell irritants, serving to call out the urge to reproduce in a lawless and unlimited way. In the poorly nourished individual the battle between bodily defense and invading microorganisms results in a quick defeat of the bodily forces with the patient dying of infection or the contest is a draw, neither side gaining a decisive victory. This long drawn out battle often results in cancer. If the body forces are vigorous enough to quickly kill invading microorganisms, the soil for cancer growth has no chance to form for cancer always grows on previously diseased tissues.

In checking slides on several long drawn out cases of cancer of the breast and lip and comparing them with slides of benign, precancerous ulcers of the lip and early lip cancer it was found that the early ulcer had a heavy growth of round cell infiltration and this persisted in the early cancer, thinning out before the advancing and invading cancer until only scattered islands were found. In a lip ulcer which becomes cancer bodily resistance was not enough to check the invader in the beginning, bodily resistance lost ground continually as the disease advanced, but in every case some round cell islands and walls of defense persisted to the end.

The ordinary local infections which are associated with early cancer are not intracellular organisms so the "chronic infection irritant" theory loses some force when applied to the problem of metastasis. Apparently with less evidence of accompanying infection the metastatic cells of the neoplasm go on proliferating with undiminished vigor. An intracellular agent is apparently necessarily present furnishing the high explosive power which produces the endless proliferation. It is a well known fact that virus infections act within the cell and the presence of a virus or several different kinds of viruses corresponding to the type of neoplasm may be the irritant passing a part of itself along with each cell division. The work of Murphy has shown that viruses are exceedingly sensitive to environmental influences. The work of Little has shown that in cancer mice the disease is transmitted to the young not by Mendel's law but by milk. The cancer strain mother mouse will transmit cancer to non-cancer strain mice if they suck her milk. Conversely cancer strain mice will remain free from the disease if they are removed immediately at birth from the cancer strain mother and allowed to suckle a non-cancer strain mouse. A few years ago the fact that chicken sarcoma could be transmitted from one chicken to another by extracts that had been passed through

* Read at the Twenty-third Annual Meeting, American Radium Society, San Francisco, Calif., June 13–14, 1938.

the finest filters, making the filtrate absolutely germ free, aroused much interest. There is but one explanation that will fit the various phenomena involved and that is that the irritating agent of cancer is a virus. We may assume that occasionally a chronic infection becomes contaminated with a virus. The cells are already proliferating in an effort to heal. The virus enters the proliferating cells. The proliferation becomes immortal. The process goes on without end. The fact that cancer occurs more often in the mouth and the gastrointestinal canal and that it strikes much more quickly in these areas tends to sustain the virus theory. Cancer may appear in the mouth or throat or tongue in an area which three weeks before had appeared perfectly well. In the stomach it may at times appear with startling suddenness, without the usual previous history of ulcer. In the internal cancer cases the diseased area is probably continuously exposed to the irritating agent after the first exposure.

On external parts where the beginning of the disease is always slow with a definite precancer history, there are undoubtedly repeated, cumulative exposures, many plantings of irritating material until finally some particular planting survives and the disease is established.

This same mechanism may be observed in the phenomenon of metastasis. Glands in the neck in mouth cancer and in the pelvis in uterine cancer show much injury and round cell reaction from invading toxic material before real cancer implants begin to show. It is a well known fact that the blood of experimental animals has a destructive effect on injected cancer cells. Only a few out of billions of injected cells survive. We are probably all exposed to cancer as we are all exposed to poliomyelitis. Many perhaps develop small cancerous lesions which heal without their presence even being known, as happens in the case of tuberculosis.

Constitutional factors, the ability to heal, may well be more important in the whole problem than purely local factors such as surgery, roentgen rays and radium.

Among lesions which are well known to be precancerous are, first, papillomata. In the areas where they are exposed to maceration as the mouth and urinary bladder, they always become cancerous. In external, dry areas such as skin and the external auditory meatus, when they become irritated or subjected to low grade infection so that a weeping and oozing provides maceration, then these external papillomas also become malignant. Second in precancer as to certainty of developing malignancy we may put radiation burns. This is so well known as to need no illustration. The radiation breaks down the epithelial protective wall, dirt and infection enter, resulting in unlimited cell proliferation. Third on the precancer list we may place scaly, scabby lesions of the lower lip. Unless checked, these always become malignant. Fourth, pigmented moles which become swollen and tender, which scab or bleed, or which grow daughter moles in the neighborhood. Fifth, eczematous lesions about the eyelids which, after years of irritation, become epitheliomas. Sixth in my experience we have benign skin tumors which grow slowly and then take on sudden explosive growth, or, being subjected to various sorts of trauma, break down and form epithelial malignancies. The forms of external precancer here mentioned are of conditions never treated locally but only by means of dietary methods to increase resistance against infections. In every one the result was satisfactory. The twenty-five year old radiation burn continues but does not get any worse (at the present time it is much better). According to previous notions, it should have become malignant years ago. The reason for giving no local treatment was that there was no definite clear cut indications for it. The time element in the conditions presented is a matter of years. It is a serious matter to apply radium to the edge of an eyelid or a lip. It is very dangerous to attack a turgid swollen tender pigmented mole with a sur-

gical operation. The benign pedunculated tumor could have been removed, but it was covered up and except for growing was doing no harm. The nail condition was tender and painful but the matter of the choice of a local remedy put off treatment. The diet used was one designed to correct vitamin and mineral deficiencies, but it was found that no diet can possibly do this completely. On account of the fact that the person has been living for many years on mineral and diet deficiencies and on account of the fact that these diet deficiencies strike the gastrointestinal tract and render absorption less active, the remedial agents must be given in at least twice the quantities that would be required for maintenance had the person never been on a deficient diet. As the normal person needs an all vitamin, high mineral diet for bare maintenance, it follows that any introduction of non-mineral, non-vitamin foods reduces life and resistance in that particular person in just the degree that such devitalized foods are eaten. As the best possible food in the best quantities cannot make up for the years the patient has been starved for vitamins and minerals, it is only by supplying concentrates that the optimum can be regained. All food deficiencies are multiple deficiencies, so multiple concentrates are used. Those supplied commercially are all deficient in vitamin B. Recent work during the last few years has shown that around 600 International Units per day is the requirement of the average individual. Most of the commercial capsules contain around 50 I.U. The complex vitamin G must also be taken into consideration. It also exists in yeast. As the best yeast tablets contain 10 units per tablet, it will be seen that around 30 to 50 tablets per day would constitute the necessary dose to obtain even fair results. This is much larger than the doses usually given.

In dealing with vitamins B and C it should be remembered that they are used up very much faster if the person is suffering from acute infection or hyperthyroidism and even chronic infections tend to deplete the system of these elements. Persons with chronic infections require two to three times the usual dosage, acute infections may require as much as ten times the usual dose. Pregnant women require four to five times the usual amount of these and some other vitamins, also much increased amounts of calcium, iodine, and iron. Recent reports show practically all obstetrical hospital admissions to be suffering from secondary anemias, many to have thyroid disease remediable by iodine, and a group of toxic conditions and multiple neuritis amenable to vitamin B therapy. These illustrate the widespread existence of mineral and other food deficiencies.

It is quite evident that cooking kills enough vitamin B in ordinary cooked and canned foods as to render the person who lives largely on cooked foods a subnormal person. When we consider the amount of sugar and white flour consumed, three-fourths of the entire food intake in most large cities, we see irrefutable evidence that the whole country is covered with a blanket of food deficiency which is responsible for many kinds of mental and physical disease.

We have found that patients get along better if some attention is paid to sodium chloride intake. The eating *ad lib* of common salt upsets the calcium and potassium balance and we use a mixture of minerals of the same percentages as Ringer's solution. This may be used in cooking or as table salt and is of undoubted benefit in stabilizing the health of these sugar-saturated vitamin-starved persons.

PARATHYROIDISM

FOLLOW-UP NOTES*

By HAROLD W. JACOX, M.D., JENNINGS M. KING, M.D.,† *and* FRANK R. BAILEY, M.D.
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SUMMARY OF PREVIOUS ARTICLE

A TYPICAL example was reported of parathyroid dysfunction in a colored female, aged thirty-seven, having no demonstrable parathyroid tumor, but exhibiting advanced osteitis fibrosa generalisata.

2. The beneficial effect of irradiation of the neck on bone lesions, blood chemistry, and clinical symptoms was emphasized.

3. The patient previously had mild urinary symptoms and later developed a small asymptomatic calculus in the right kidney.

TERMINAL ADMISSION

The patient was re-admitted to the Western Pennsylvania Hospital on July 22, 1939, with a chief complaint of pain in the right upper quadrant of the abdomen and right costovertebral area radiating to the inguinal region. She stated this had begun about 9 o'clock of the previous evening and that she had a similar attack about one week prior to the present one. In the past she had noted some intolerance to fatty foods and on a few occasions recently she had noticed hematuria.

Upon examination there was considerable tenderness and definite muscle spasm in the right upper quadrant and in the right costovertebral area. The clinical impression was that of subacute cholecystitis and renal calculus. The pertinent laboratory findings were as follows: The urinalysis showed 3 plus albumin, with many red and white blood cells. The Kahn test was 1 plus. The non-protein nitrogen was 69 mg. per 100 cc. of blood, and the creatinine was 3.4 mg. per 100 cc. of blood. The hemoglobin was 80 per cent, the red blood cells, 4,200,000 and the white blood cells 14,000 per cubic millimeter. The differential count was 80 per cent polymorphonuclears, 15 per cent small lymphocytes, 2 per cent large lymphocytes and 3 per cent transitionals and large mononuclear cells. The blood calcium was elevated to 12.1 mg. per 100 cc. and the blood phosphorus was decreased to 2.1 mg. per 100 cc. The phosphatase was elevated to 12 Bodansky units. Roentgen examination of the abdomen demonstrated a dense irregular shadow at the level of the sacral promontory on the right exactly resembling the opacity previously described in the lower half of the right kidney. Coarse striations were still present in the pelvic bones. It was concluded that the renal calculus was impacted at the lower end of the right ureter. The patient's general course was a gradually declining one, with the continuous progression of chills and fever and a slowly failing heart. The patient's general condition was such that only symptomatic treatment was possible. She died on the twenty-first day in uremic coma.

Autopsy was performed eight hours after death by Dr. Paul Gross of the Institute of Pathology.

Excerpts Taken from the Autopsy Protocol (A-15).

Gross Anatomy: No parathyroid tissue or adenoma were found.

Heart: The heart was normal in position and weighed 250 grams; of average size and shape, markedly flabby in consistency; of a peculiar orange-red color, considered to be postmortem change. This orange-red color was particularly well seen on section of the myocardium. The endocardium showed marked postmortem hemoglobin staining; coronary orifices and vessels were normal; otherwise no striking change was noted.

Aorta: The aorta was of average circumference; intimal surface was smooth and glistening; wall was elastic. Very little atheromatous change was noted. Peripheral vessels showed no significant sclerosis.

Lungs: The right lung weighed 400 grams and the left lung 325 grams. They were of average size and shape. The pleural surfaces

* Follow-up notes on a paper on "Parathyroidism: Effect of Irradiation of the Neck on the Repair of Bone Lesions" published in the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY, June, 1939, *41*, 970–978.

† Deceased.

were smooth and glistening; dark black in color. The consistency was boggy throughout. On section, cut surface retracted; exhibited a dark black and red spongy surface, from which an abundant amount of blood-tinged, frothy fluid could be expressed. No nodules or consolidation were found. The tracheobronchial tree was dilated and the mucous membrane markedly reddened. The tracheobronchial lymph nodes were anthracotic, moderately enlarged, and edematous.

Liver: The liver weighed 2,150 grams. It was markedly enlarged; of a mottled orange and yellow color and its edges were rounded. Considerable adhesions of a fibrous nature between anterior surface and diaphragm were seen. Consistency was flabby. On section the cut surface showed marked postmortem change with here and there poorly defined patches of yellow fatty areas.

Spleen: The spleen weighed 175 grams. It was extremely soft; fibrous, perisplenic adhesions of average size and shape; on section exhibited a diffluent pulp.

Gallbladder and Biliary Passages: The gallbladder and biliary passages showed no striking abnormalities.

Kidneys: The left kidney weighed 225 grams and the right kidney 300 grams. They were markedly enlarged, the right more than the left; very soft and flabby in consistency; yellow-gray in color. Capsules stripped with some difficulty, revealing finely granular, mottled gray and yellow-gray surfaces, except in the right kidney, where in addition clusters of pinhead size, yellow abscesses were found over the entire surface. The pelvis and ureter on the left were normal; on the right, marked dilatation of the pelvis, calyces, and ureter was found. The content of the pelvis and ureter was a turbid, gray-yellow, somewhat viscid fluid. At the junction of the middle two-thirds and lower third of the right ureter, a large conical calculus the shape of a renal calyx was found impacted. The bladder showed moderate hyperemia and granularity of the trigone; otherwise no striking abnormality was noted.

Miscroscopic Examination:

Heart: Considerable interstitial edema and degeneration were present. These changes appeared to be postmortem.

Lungs: Marked edema, congestion. Some emphysema. No pneumonia.

Liver: Marked fatty change.

Kidneys: Marked postmortem change with moderate infiltration by monocytes and polymorphonuclears in foci. Calcification of collecting tubules.

Anatomical Diagnoses: Hyperparathyroidism, clinical. Osteoporosis, with healed spontaneous fractures, multiple, clinical. Renal calculus, right ureter. Pyelonephritis, right. Cloudy swelling of kidney, marked, left. Acute bronchitis. Edema and congestion of lungs. Hepatomegaly, with fatty change. Postmortem change of viscera, marked.

COMMENT

As was stated previously, we think we were dealing with hyperfunctioning parathyroids which may have been so affected by the irradiation that they could not be found, even at autopsy.

The cause of death was extensive hepatic and renal damage, perhaps initiated by the blocking of the ureter, by a renal calculus. Renal complications have been the cause of death in a number of reported cases of parathyroidism.

THE COMBINED ACTION OF ROENTGEN RAYS AND SULFANILAMIDE ON *STAPHYLOCOCCUS AUREUS**

By RUBIN FLOCKS, O. N. FELLOWES, *and* H. DABNEY KERR
IOWA CITY, IOWA

IN 1935, Brocq-Rousseu[1] reported that the combined action of ultraviolet light and sulfanilamide on beta-hemolytic streptococci was many times more lethal than the action of the ultraviolet ray or the drug alone. This observation led us to attempt to ascertain by in vitro and in vivo experiments whether or not there was any synergistic action between sulfanilamide or prontosil soluble and roentgen rays.

The in vitro method was performed in Petri dishes which contained the drug and the organisms suspended in a meat infusion broth of pH 7.4. During the exposure to the roentgen rays, the upper halves of the Petri dishes were removed. Prontosil soluble and sulfanilamide were made up in 0.4 per cent concentration in the broth and 10 cc. of this was used per Petri dish. To the drug in the containers was added an inoculum from a three hour broth culture of a hemolytic toxin-producing strain of *Staphylococcus aureus*. This inoculum of organisms contained about 10,000 cocci as measured by plate count. Suitable controls to measure the effect of roentgen rays on the organisms, the effect of roentgen rays on the drugs themselves (the organisms added subsequently) and a control for growth were carried out.

In the first exposure of both drugs, plus the organism, to roentgen rays, 100 r was given. The factors were 133 kv., 5 ma., no filter, 40 cm. distance, 1 minute and 36 seconds. After exposure, 1 cc. of each of the experimental and control mixtures was plated and in no case did any plate have a count greater than one hundred colonies. In Table I is represented the colony counts of the various experimental and control mixtures.

TABLE I

Experimental and Control	Colony Count per cc.
Staph. aureus +0.4 per cent prontosil sol. +roentgen rays	63
Staph. aureus +0.4 per cent sulfanilamide +roentgen rays	64
Staph. aureus +0.4 per cent prontosil sol.	64
Staph. aureus +0.4 per cent sulfanilamide	72
Staph. aureus +roentgen rays	80
*0.4 per cent prontosil sol. +roentgen rays	86
*0.4 per cent sulfanilamide +roentgen rays	95

* *Staph. aureus* added after exposure.
Original inoculum—10,000 organisms per 10 cc.

In the second exposure to roentgen rays of similar mixtures of drugs and organisms, 200 r was given. The factors were 133 kv., 5 ma., 1.0 mm. aluminum filter, 40 cm. distance and 8 minutes. The same procedure as to plating from each experimental and control mixture was followed, as was described previously. The colony count for each preparation was generally reduced below that in Table I, as may be seen in the results in Table II.

The in vivo experiment consisted of infecting mice in groups of 20 with an approximate dose of 10,000 staphylococci and exposing them to roentgen rays, sulfanilamide or prontosil soluble and either of the two drugs plus roentgen rays. An untreated infected control group was included.

Sulfanilamide was tested first by infecting four groups of 20 mice with the dose of

[1] Brocq-Rousseu, D. Photo-sensibilisation d'un streptocoque. *Compt. rend. Soc. de biol.*, 1935, *119*, 272.

* From the Departments of Urology, Bacteriology and Radiology, College of Medicine, State University of Iowa.

Table II

Experimental and Control	Colony Count per cc.
Staph. aureus +0.4 per cent prontosil sol. +roentgen rays	48
Staph. aureus +0.4 per cent sulfanilamide +roentgen rays	20
Staph. aureus +0.4 per cent prontosil sol.	65
Staph. aureus +0.4 per cent sulfanilamide	59
Staph. aureus +roentgen rays	50
*0.4 per cent prontosil sol. +roentgen rays	76
*0.4 per cent sulfanilamide +roentgen rays	62

* *Staph. aureus* added after exposure.
Original inoculum—10,000 organisms per 10 cc.

staphylococci and three hours later giving those two groups which received it, according to the plan, their first injection of 1 cc. of 0.4 per cent sulfanilamide. One hour later the two groups which received roentgen rays were given 100 r at 45 cm. distance at 133 kv. and 5 ma. for 3.4 minutes with a 1 mm. aluminum filter. From here on, the groups given the drug obtained it at four hour intervals in a dose of 1 cc. of a 0.4 per cent concentration for four days. The next morning the two groups given roentgen rays were exposed again to 100 r, using the same factors as at the first treatment. The number of mice surviving each type of treatment is found in Table III.

Table III

Type of Treatment	No. of Mice	Survival
Staph. aureus alone	20	4
Staph. aureus +roentgen rays	20	16
Staph. aureus +sulfanilamide	20	16
Staph. aureus +sulfanilamide +roentgen rays	20	10

Prontosil soluble was tested in the same manner as was sulfanilamide in mice in groups of 20. Two groups of mice were irradiated on successive days by exposing them to 100 r each day with the above factors. The drug was administered to those groups receiving it at four hour intervals for four days. The data in Table IV show the survival of the experimental and control mice.

Table IV

Type of Treatment	No. of Mice	Survival
Staph. aureus alone	20	0
Staph. aureus +roentgen rays	20	18
Staph. aureus +prontosil sol.	20	18
Staph. aureus +prontosil sol. +roentgen rays	20	14

RESULTS

To summarize this investigation, it was found that in the in vitro experiments using a small inoculum of staphylococci there was a marked reduction in the number of surviving organisms after exposure to sulfanilamide, prontosil soluble or to either drug combined with roentgen rays. The numbers of cocci surviving exposure to the drugs plus roentgen rays were less than for those surviving either drugs or roentgen rays alone but the difference was probably not a significant one due to inherent errors in the plate counting method.

In the in vivo experiment, it is surprising to note that the combined action of drugs and roentgen rays permitted less survivors than did either of the drugs or roentgen rays alone. What the answer to this may be is not known. However, it has been noted clinically that patients with infections treated coincidentally with roentgen rays and sulfanilamide have not responded as well as similar patients treated with one or the other.[2] Therefore, under the conditions of this experiment, no synergistic reaction between sulfanilamide and roentgen rays was demonstrated.

[2] Kelly, J. F. Personal communication.

Vol. 44, No. 1

DESIGN OF A FOUR GRAM RADIUM BOMB

By A. H. WARNER, Ph.D., *and* R. H. NEIL, A.B.
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THE problems that arise in connection with the installation of a large radium pack fall into two classes. In the first class we may put those questions relating to the location and size of the treatment room and its relation to the other activities of the cancer treatment center. The second group of problems concerns the proper design of the bomb itself, so that adequate protection is incorporated without sacrificing convenient handling for treatment.

The location must be easily accessible for patients, with all provisions for their comfort in its immediate vicinity. Supervision during the long treatments must be convenient. The possibility of stray radiation in adjacent rooms must be guarded against. The solution of these problems was found in a location below ground level, in the vicinity of the supervoltage treatment room. The room is surrounded on three sides by the foundations of a ten story concrete building. A maze of brick and concrete stops stray radiation on the other side and provides easy entrance. The space above is used for ordinary radium treatments, and is completely protected by the 6 inch steel and concrete slab that intervenes between it and the pack. Complete facilities for the patients' comfort and care had already been provided in connection with the supervoltage installation.

In considering the problem of protection, we find a tungsten alloy, lead, and mercury available. Tungsten alloy has a density of 17, and permits a smaller structure. It has the serious disadvantages of costing several dollars per pound, must be imported from England, and can be made up only in small pieces. Lead has a density of 11, and has been used in a number of installations. Adequate protection requires a bulky structure, and the soft nature of the metal necessitates a complete supporting structure of steel. It has the advantage of being readily available and cheap. Mercury has a density of 13.6, which requires a thickness only slightly greater than tungsten alloy, and reduces the dimensions to values considerably below those necessary for lead. The cost is approximately 90 cents per pound, and since mercury is liquid, the structure must be of steel, entailing very considerable machine work.

In making a choice between these materials, tungsten alloy was eliminated on account of the high cost, difficulty in working and the necessity of importing a semi-finished structure. In choosing between lead and mercury, machine work on the structures would be required in both cases, but mercury would provide complete protection in a structure of smaller dimensions than would be required with lead. When the supporting structure for mercury was found to be relatively simple and less expensive than the one required for lead, the importance of securing protection with convenient size was felt to be sufficient to justify the additional cost of the mercury filling. A further consideration is the fact that mercury is a staple commodity, and will have a market value only slightly less than the original cost if the structure should ever be dismantled.

DESIGN OF THE RADIUM BOMB FOR PROTECTION

The radium bomb has been designed to contain 4 grams of radium, made up in forty units of 100 milligrams each, enclosed in gold and platinum iridium with an equivalent filtration of 0.615 mm. of platinum. Eight roentgens per milligram per hour at one centimeter may be expected through 0.5 mm. of Pt.* Neglecting the

* Kaye, G. W. C., and Binks, W. Ionization measurement of gamma radiation. Am. J. Roentgenol. & Rad. Therapy, 1938, *40*, 80–91.

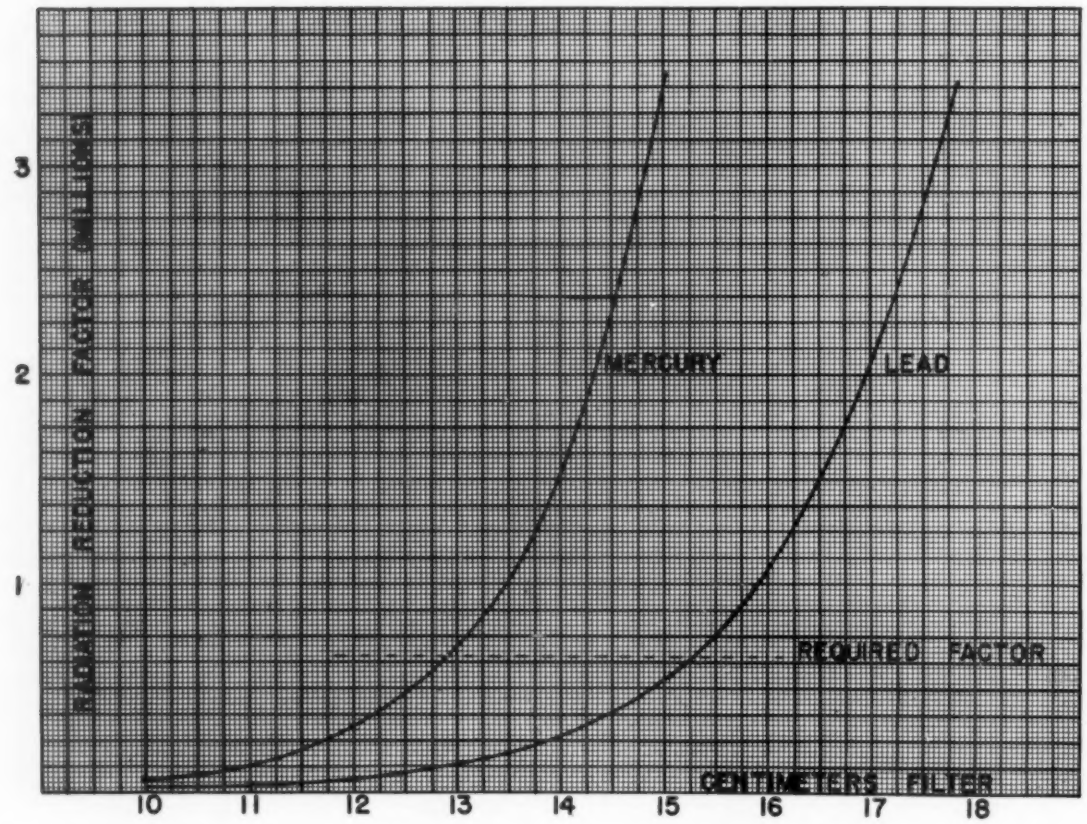

FIG. 1. The factor by which the intensity of the radiation is reduced is plotted against the thickness of the surrounding filter. The required factor (640,000) is obtained by 12.9 cm. of mercury or 15.2 cm. of lead.

additional filtration, and assuming a point source of 4 grams, we may expect approximately 32,000 r per hour at a distance of 1 cm.

Assuming that a technician is in the vicinity of the bomb for two hours daily and is not to receive a greater dose than 0.1 r, *the radiation must be reduced by a factor of 640,000 by the time it reaches the outside of the container*. This reduction will be due to two factors: (1) distance and (2) the mercury of the housing.

Consider a point source of radiation of 4,000 mg. in an attenuating medium of mercury or lead: The reduction factor, F, is the ratio between the intensity at 1 cm., I_1, and the intensity, I_d, at a distance d centimeters away.

$$F = \frac{I_1}{I_d}$$

The intensity decreases in proportion to the square of the distance. The presence of the lead or mercury causes the intensity to decrease further by a certain percentage for each centimeter it travels away from the source. These facts may be expressed by means of the equation

$$I_d = \frac{I_1}{d^2} e^{-kd}$$

where e is the natural base of logarithms.

Rearranging this equation, we can get an expression for the reduction factor.

$$F = \frac{I_1}{I_d} = d^2 e^{kd}$$

For mercury $k = 0.64$; for lead $k = 0.52$.

By putting in various values of the distance d we can calculate F. This has been done for mercury and lead for several dis-

tances, and the results are given in Table I below, and in the graph of Figure 1.

TABLE I

d	Lead	Mercury
10	18,100	
11	35,300	138,200
12	73,500	318,000
13	149,000	692,000
14	284,000	1,525,000
15	550,000	3,320,000
16	1,050,000	
17	2,030,000	
18	3,840,000	

It can be seen from the graph that to get the required protection factor (640,000) we must use 15.2 cm. of lead or 12.9 cm. of mercury.

The radium cannot be concentrated at a point; first, because of its bulk, since it is distributed into forty 100 mg. units, and secondly, because it must be arranged to give a uniform distribution of intensity over the treatment portal. These considerations resulted in the placement of the radium at a distance of 2.5 cm. from the center of the container. The spheres of lead and mercury providing the required protection must therefore be of 17.5 and 15.4 cm. radius respectively.

Fortunately, steel hemispheres (known as "bull plugs" in the oil industry) of 15.3 cm. inside radius with 1 cm. walls, are obtainable locally. Two such hemispheres welded together and filled with mercury form the nucleus of the present design. It weighs 450 pounds.

A lead filled sphere providing the same protection would weigh 125 pounds more and the larger size would be less convenient for treatment. The special fabrication of the larger sphere would have been so expensive ($200.00) compared to the cost of the bull plugs ($10.00) that the lead unit would have cost very little less than the more desirable mercury unit.

MECHANICAL DESIGN

For convenience in treatment, the radium bomb must be so constructed that all treatment angles and distances can be obtained with a minimum of mechanical effort on the part of the technician.

In roentgen therapy at this Institute, it has been found possible to set up all the necessary angles and positions with very little effort if the tube is kept horizontal and at a fixed height. The tube rotates about its long axis directing the beam into any angle between the horizontal and straight down. A mobile table is provided that can be raised and lowered electrically and can be oriented easily in any direction. With this combination radiation can be directed to any point in the patient's body from any desired direction. The success of this technique in irradiation indicated that the radium bomb could also be put at a fixed height, thereby eliminating the troublesome problem of providing an easy vertical motion for that heavy structure.

It seemed desirable to provide for treatment distances of *any* value from 1 or 2 cm. to as much as 15 cm. Six and 10 cm. have been most used in the past, but greater flexibility seemed desirable and has been attained in the design.

The absolute minimum of responsibility should be placed upon the technician. It was therefore required that after setting an indicator on the bomb for the treatment distance, and putting the patient in position, the technician should only be required to set a clock and close a switch at a remote panel; the radium would then be automatically moved from safe position to treatment position, the treatment would be timed, terminated by withdrawal of the radium, and the technician signaled to change patients.

The essential features of the design are shown in Figure 2. The bomb can be rotated about its horizontal axis by means of the worm and gear, *G*. The radium, mounted in the cup, *C*, at the end of the rod, *D*, is contained in a cylindrical cartridge, *A*, filled with mercury. This cartridge slides in a tube that is welded into the steel sphere, *B*, which is also filled with mercury.

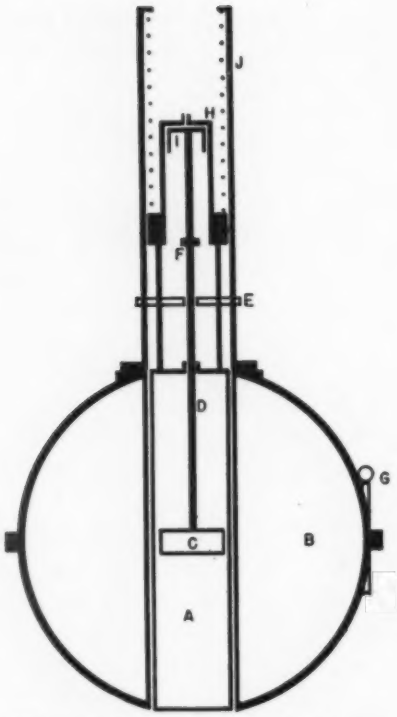

Fig. 2. The relative position of the parts of the mechanism when the radium is in safe position.

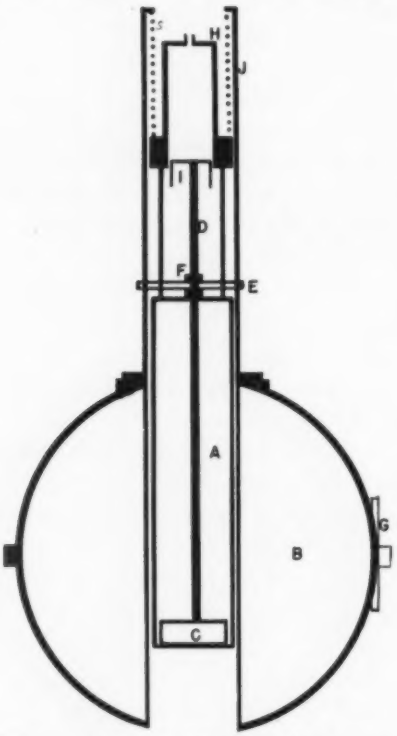

Fig. 3. The relative position of the parts of the mechanism when the radium is in treatment position.

To place the radium for treatment, *C* is pushed to the proper treatment distance as set by the stop, *E*, and collar, *F*. The cartridge is moved up until its lower end is against the radium, and its upper end against the stop, *E*. The apparatus is then in the position shown by Figure 3.

The only filter between the radium and the patient is now the steel end of the cartridge *A* and that of the cup *C*.

Fig. 4. The completed installation.

The movement of the radium and the cartridge is produced by pumping oil into the space between the head of the cylinder, *H*, and the piston, *I*. The cylinder is attached to the cartridge and the piston to the rod, *D*, and hence to the radium. The cylinder, *H*, moves in the guide, *J*, which is attached to the bomb.

The oil forces the piston, *I*, down until the collar, *F*, contacts the stop, *E*. The piston can no longer move and consequently the oil drives the cylinder up, carrying the cartridge up until its bottom strikes the radium cup, *C*, and its top simultaneously arrives at the bottom of the stop, *E*.

When motion has ceased, the oil pressure rises rapidly and actuates a mercoid switch. The switch energizes a magnetic check valve which prevents the retreat of the oil and cuts off the current to the oil pump motor.

To return the radium to safe position the check valve is released and the oil pumped back into a reservoir. Strong springs then return the piston and cylinder to their original positions. An excellent feature of this arrangement is that the radium is returned to safe position automatically in case the oil pressure is lost.

The control panel is placed in another room, approximately 40 feet from the bomb. A lock switch prevents unauthorized operation. Telltale lights indicate the position of the radium, and a pressure gauge provides a check upon the operation of the oil pump. The mercoid switch is also mounted here, where it can be adjusted in connection with the pressure gauge.

Measurements with a Lauritsen electroscope have shown that the bomb provides the required protection, and that on the floor above the tolerance dose is not exceeded while the bomb in is use.

Figure 4 is a photograph of the completed installation.

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Twenty-sixth Annual Meeting: 1941, to be announced.

EDITORIAL

MEDICAL USES OF RADIUM

THE Special Reports No. 232 and 236 of the Medical Research Council of Great Britain, covering the years 1937 and 1938 and dealing with the medical uses of radium*, are as interesting and valuable as the several reports which have preceded them. Although the heading "medical uses of radium" implies that these reports cover only investigations of the action of radium, this is not the case. While most of the experiments on animals are carried out with radium, much of the clinical radiotherapy includes radium and roentgen rays, as well as a combination of one or both of these agents with surgery.

Among many interesting points brought out in these reports is the statement that, although the prediction had been made that artificial radioactive bodies would replace radium, such a development is not in sight of fulfilment. However, a development made by physical chemists is likely to be important to physiologists because it will now be possible to trace the fate of substances introduced into the body, both in place and time. If a small trace of radioactive phosphorus (for example) is mixed with ordinary phosphorus, the presence of the latter is proved by the presence of the former, and this can be shown by ionization methods with a delicacy far superior to ordinary gravimetric measurements.

Professor F. L. Hopwood, of St. Bartholomew's Hospital Medical College, carried out experiments on the stability of inorganic and organic colloids, on the oxidation of potassium meta-bi-sulphite, and on the breakdown of hydrogen peroxide in dilute aqueous solutions when irradiated with neutrons, or with gamma rays.

The results of these experiments led him to conclude that the effects due to neutrons were of the same nature as those due to gamma rays, but that the former were far more effective than the latter; and that negatively charged colloidal particles became more stable, and positively charged particles less stable, when irradiated with either neutrons or gamma rays. Professor Hopwood thought his experiments indicated that the radiations acted primarily on the water, and that the colloids and chemical compounds acted merely as indicators. "If this view is correct, then the role played by water in the animal body during irradiation must be significant and possibly predominant." To those who are familiar with Failla's experiments in this country and with his ideas on the probable action of roentgen rays and radium on cancer cells as well as on normal cells, Professor Hopwood's results and conclusions will be most interesting.

Mayneord, who investigated the variation in depth doses for teleradium units under different physical conditions, found that depth doses varied rapidly with focal-skin distance, with filtration, and with the arrangement of the radium. At short focal-skin distances (2 or 3 cm.) this factor is of great importance, but its importance disappears at distances of about 10 cm., with the sizes of radioactive source likely to be used in practice. The results indicate that for distances of 1 meter the gamma rays of radium, filtered with about 1 mm. of platinum or its equivalent, yield, according to field size, doses of about 65 per cent at a depth of 10 cm. For large fields (400 sq. cm) the depth dose is increased very little by fil-

* Medical Uses of Radium. Summary of Reports from Research Centres for 1937. Paper. Price, 35 cents. Pp. 48, with 5 illustrations. Medical Research Council, Special Report Series, No. 232. London: His Majesty's Stationery Office, 1938.
Medical Uses of Radium. Summary of Reports from Research Centres for 1938. Paper. Price, 30 cents. Pp. 49, with 5 illustrations. Medical Research Council, Special Report Series, No. 236. London: His Majesty's Stationery Office, 1939.
(May be obtained from British Library of Information, 50 Rockefeller Plaza, New York City.)

tration up to 1 cm. of lead. The variation in depth dose with size of field appeared much smaller for very penetrating radiations than for less penetrating radiations.

In the Medical Research Council Report for 1936, mention was made of experiments by Spear and Glücksmann, of the Strangeways Laboratory, Cambridge, on the effect of gamma rays on the tadpole. These experiments had shown that mitotic activity can be reduced and held in check by irradiation, by fasting, and by chilling; that gamma radiation causes degeneration of cells only in the mitotic regions of the tadpole and in areas to which recently divided cells normally migrate; that fasting causes degeneration only among cells which are in process of differentiating, while chilling does not cause degeneration but diminishes cell division by slowing down cellular processes, expecially mitosis.

During 1937 and 1938 these experiments were continued by studying the effect of gamma radiation on the retina and brain of fasting tadpoles. It was found that fasting alone causes cell division to fall to about 10 per cent of the normal in ten days, and to zero within twenty-one days after withholding food. When food is given, mitosis returns after five days of feeding and reaches 30 per cent of the normal. Degeneration in the germinative zones was not produced, but some degeneration was observed among undifferentiated cells of the inner nuclear layer of the retina. When mitosis was absent, irradiation of fasting tadpoles was not followed by any detectable change; but when food was given one week after exposure, a few degenerate cells appeared almost immediately in the germinative zone, and this was followed, after feeding for five days, by some mitotic activity. These results were thought to confirm previous conclusions that the degeneration seen after small doses of radiation is related to the presence of potential dividing cells which are unable to accomplish mitosis because they have been damaged by exposure and break down on attempting division. According to Glücksmann, the inner nuclear layer of the retina contains many undifferentiated cells destined later to become either ganglion or visual cells. This interesting observation probably explains why, when the eyes of young, rapidly growing animals are irradiated soon after birth, the growth of the inner nuclear layer is retarded more or less according to the dose of rays, while the other layers of the retina continue to grow normally, and assume a peculiar plicated arrangement within the eyeball, the development of which is also retarded by irradiation.

Keeping tadpoles at a constant temperature of 0.3° C. reduces the number of cells entering mitosis, while dividing cells are arrested in metaphase. When returned to room temperature, the cells in arrested mitosis complete their division and recover their normal rate of entry in mitosis. When tadpoles are irradiated at room temperature and are then kept at 0.3° C., degenerative cells in the germinative zone are not seen; but when returned to room temperature, degenerative cells appear as if they had been kept at room temperature throughout the experiment. From these and earlier experiments the authors concluded that, after exposure to radiation, potentially dividing cells break down when they again attempt to divide.

Mottram, continuing the investigations undertaken in 1936, and using mouse carcinoma 2146, devised a method of spaced irradiation in which treatment was given only when the tumor was considered radiosensitive and was discontinued when the tumor was regarded as radioresistant. In other words, treatment was continued as long as the tumor continued to grow, but was stopped as soon as the tumor ceased to grow or began to regress. The presence or absence of dividing cells was used to measure radiosensitiveness, on the assumption that when mitoses were absent metabolism and growth would be inactive and radioresistance high.

With these tumors it was found that, after thirty minutes' exposure to gamma rays at 3 r/min., mitosis had returned to normal in twenty-four hours. Immediately after sixty minutes' exposure, only about 2

per cent of the normal number were present When a continuous exposure of three and a half hours was given, much of the dose was applied when the tumor was presumably resistant. On the other hand, repeated doses of thirty minutes, at intervals of twenty-four hours did not perceptibly reduce the number of mitoses twenty-four hours after any one of the exposures.

Other experiments were made to see whether continuous treatment for three and a half hours would have greater effect on the mouse tumor than seven treatments of thirty minutes at intervals of twenty-four hours. Thirty-three tumors were treated. With spaced irradiation, eleven out of fifteen tumors disappeared, while with continuous irradiation only eight out of fifteen disappeared.

In another investigation of the effect of irradiation on precancerous skin lesions, mice were painted with 3:4 benzpyrene twice a week for seventy-five days; some were kept as controls, and the remainder were exposed to 1,440 r*, to 480 r*, or to 160 r* of gamma rays about the sixteenth day. It was found that irradiation greatly increased the incidence of tumors. In the control mice five warts were observed; in those exposed to 160 r, six warts; in those exposed to 480 r, thirteen warts; and in those exposed to 1,440 r, fifteen warts. Mottram concluded that if the entire lesion could be given a dose of about 6,000 r good results might be expected, but if the lesion, or any part of it, be given a smaller dose, instead of preventing the onset of malignancy, the treatment would tend to have the reverse effect.

Further experiments, carried out in 1938 by Mottram and Read, represented an attempt to determine the tolerance concentration of radon for mice. Air tight boxes maintained six mice in good health, the carbon dioxide being absorbed by potash and the air being changed once a day. In one box radon seeds were crushed daily (except Saturday and Sunday) and, as soon as the radon was released, a small electric fan mixed it with the air in the box. In one experiment a concentration of 10^{-9} curies/cc. was maintained for twenty-six days; the mice died on the twelfth, twenty-third, twenty-third, twenty-fifth and thirtieth days, and one survived until the sixty-fifth day. The controls remained alive and well. In a second experiment a concentration of 10^{-10} curies/cc. was maintained for 161 days. The animals remained well and both sets had young. In a third experiment a concentration of 5×10^{-10} curies/cc. was maintained for forty-three days. Only one mouse survived to the forty-eighth day; the tolerable concentration, therefore, was between 5×10^{-10} and 10^{-10} curies/cc. The pathological changes found in the mice were those commonly observed in animals exposed to radiation: leukopenia, atrophy of lymphoid tissues, ovaries and testes. The bone marrow contained chiefly mature polymorphonuclears.

Thinking that the leukopenia in radium workers might be due to breathing radon, samples of air at three representative institutions were taken, and the radon concentrations were measured by the ionization produced by their alpha and beta particles. In almost all cases a measurable concentration was present, usually between 10^{-13} and 10^{-12} curies/cc. Measurements made in the radium safe of a hospital when leaky needles were present suggested that, when the safe door was opened, most of the radon polluted air in the safe was emptied into the room. A fan was installed to remove the air from the safe by piping it outside of the building. The few radium workers employed by a radium company, who have shown leukopenia, did so before the ventilation was improved; after this, the average concentration was about 2×10^{-12} curies/cc.

Desiring to compare the doses required to give an equal skin erythema for continuous irradiation over periods of two hours, three days, seven days and fourteen days, Colwell (1937) exposed symmetrical areas on the thighs of two-thirds the minimal lethal dose. Equal fractions of the minimal lethal dose for any period appeared to produce identical degrees of erythema, but any

* There were twenty mice in each group.

advantage was in favor of short duration. A slightly higher percentage of the estimated minimal lethal dose is required at the shorter times.

An attempt was also made to compare the effects on the skin of the thigh produced by roentgen rays and by radium. The area irradiated was a circle 4.2 cm. in diameter, the radium being mounted on a stent and base plate mold with a radium skin distance of 1.5 cm. In the case of roentgen rays, an aperture 4.2 cm. in diameter was cut in a piece of sheet lead backed by electroplast felt with a ring of Cellon around the aperture to prevent scatter from the edge of the lead. The roentgen rays were generated at 200 kv., 3.5 ma., focal skin distance 40 cm., with a filter of 1 mm. Cu, 1 mm. Al, and a half-value layer of 1.5 mm. Cu. The erythema produced by roentgen rays formed a sharply defined area the size of the field, while that produced by radium covered an area about 5 cm. in diameter, fading towards the edges. Symmetrical areas on the anterior aspect of the two thighs of the sixteen patients were irradiated with radium or with roentgen rays, the dose varying from 1,200 to 3,500 r (roentgen rays) and 1,200 to 4,375 r (radium). In all cases but one the reaction to roentgen rays was greater than that to radium.

With reference to the production of inheritable mutations in germinal material, it was already known that variations in the intensity of roentgen rays or gamma rays between 200 r and 1 r per minute caused no difference provided the total dose was the same. The production of mutations was also independent of fractionation of dose and wave length when total ionization was constant. In further experiments by Muller and Raychaudhuri (1938) an intensity of gamma rays as low as 1/20 r and 1/100 r per minute was used on mature spermatozoa of *Drosophila* contained in the receptacles of inseminated females. In other series the same dose of roentgen rays generated at a potential of 60 kv. was given in about twenty minutes. Even an intensity of 1/100 r per minute was found as effective as 1/20 or 100 r per minute when the total ionization was the same. Conversely, extending the time of irradiation from a half hour to thirty days did not affect the result with the same total ionization. Moreover, differences in wave length between roentgen and gamma rays, combined with the variations in time and intensity employed, did not show any perceptible difference. This applies to "point mutations" as well as to changes involving breakage and reunion of chromosome pieces. But in the latter, unlike gene mutations, the frequency of the chromosomal rearrangements did not vary in direct proportion to the total dose, but exponentially when low intensities of gamma rays were used over an extended period.

Pursuing their experiments on tolerance to irradiation, Russ and Scott exposed young male and female rats to forty-seven times the daily tolerance dose recommended by the International Committee on Protection. The total irradiation was the same as in previous experiments. The only difference was that the rats were exposed for only five days a week, instead of seven days, and the days lost were made up by continuing the treatment for the necessary longer time. After forty-seven times the toleration dose on 121 days, with two free days a week, both male and female rats were lighter in weight and had a much higher death rate than the controls. The difference in weight was never made up; when the rats were a year old, the controls were fine, healthy rats, while most of those irradiated in their youth died young, and the survivors were thin and prematurely aged. When mated to normal males, the females became pregnant, but in only one case did the young survive birth for any length of time. When mated to normal females, the irradiated male rats did not produce any young for several months. Sections of testes and ovaries, made six months after the end of irradiation, showed changes just as pronounced as when the same total dose of the same intensity was given continuously.

ARTHUR U. DESJARDINS

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. C. B. Peirce, Royal Victoria Hospital, Montreal, Canada. Annual Meeting: Hotel Statler, Boston, Mass., Oct. 1–4, 1940.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Next annual meeting: 1941, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: 1941, to be announced.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland, Ohio, Dec. 2–6, 1940.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets twice annually in May and September.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles Co. Med. Soc.
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. L. J. Taormina, 1093 Gates Ave., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to May inclusive at the Hotel Sherman.

Cincinnati Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. H. A. Mahrer, 10515 Carnegie Ave. Meets at 6:30 P.M. at Mid-Day Club rooms on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. P. R. Weeks, 520 Republic Bldg., Denver, Colo. Meets third Friday of each month.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. J. N. Moore, 210 Professional Bldg., Ocala, Florida. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meetings held quarterly, on the fourth Sunday of the month.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, 23 E. Ohio St., Indianapolis, Ind. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. J. C. Bell, 402 Heyburn Bldg., Louisville. Meets annually in Louisville on third Sunday afternoon in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. J. E. Lofstrom, 1536 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. I. I. Cowan, Mt. Sinai Hospital, Milwaukee, Wis. Meets monthly on first Friday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M., at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. A. O. Hampton, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. W. J. Marquis, 198 Clinton Ave., Newark. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. R. D. Duckworth, 170 Maple Ave., White Plains, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year—January, May, November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport, Pa. Meets annually. Time and place of next meeting to be announced.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave. Meetings held second Wednesday each month, 4:30 P.M., October to June at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. S. C. Davidson, 277 Alexander St. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill: 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second six months at Lane Hall.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. L. W. Baird, Scott and White Hospital, Temple, Texas. Next annual meeting, January 18, 1941, Sherman, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. V. W. Archer, University Hospital, University, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday of each month at the College Club, Seattle.

CUBA

SOCIEDAD CUBANA DE RADIOLOGICA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

FACULTY OF RADIOLOGISTS
Secretary, Dr. Barbara M. Key, 32 Welbeck St., London, W. 1, England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive for scientific discussion.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto, 5, Ontario.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium). Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel. Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aertze.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the spring, and one in the fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, M. Ponzio, University of Turin, Prof. Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly on first Monday at 8 o'clock.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St. Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen. Meets the second Wednesday of each month from October to July in Copenhagen, at 8'oclock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6:30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

PRELIMINARY PROGRAM

FORTY-FIRST ANNUAL MEETING AMERICAN ROENTGEN RAY SOCIETY

The Forty-first Annual Meeting of the American Roentgen Ray Society will be held at the Hotel Statler, Boston, Massachusetts, October 1–4, 1940. Boston is an ideal convention city and the weather is apt to be perfect at this time of year. The Hotel Statler has exceptional facilities for such a convention and is surpassed by only a few of the metropolitan hotels. The combination of the World's Fair in New York before the meeting or a sightseeing trip through northern New England after the meeting should be ideal foi those who have not recently been to Boston. The program has been planned in order to allow plenty of time for discussion, a special intermission for the study of scientific and technical exhibits, and the afternoon instruction courses have been changed slightly, providing a single important clinical lecture of interest to all the members immediately after lunch, with the individual instruction courses, about fifteen each day, following the clinical lecture.

There will be a special entertainment for the ladies, including a reception and concert at the famous Isabella Stewart Gardner Museum and a sight seeing trip to Wayside Inn with luncheon at the Inn. Other short sight-seeing trips to historic spots in and around Boston are available to those who desire them.

The annual golf tournament will take place on Monday, September 30, with the usual dinner at the golf club Monday evening. The local chairman of the golf committee is Dr. P. F. Butler, 35 Bay State Road, Boston, Mass.

The scientific sessions will begin Tuesday morning, October 1, at 8:30 A.M. and continue through Friday, October 4. The detailed program is given below. The abstracts will be printed in the regular program which will be given out at the time of registration.

The meeting of the Executive Council will be held at noon on Sunday, September 29, in the Hotel Statler and the executive business sessions will be held, as usual, on Tuesday and Thursday afternoons, October 1 and 3 respectively, at 4:30 P.M.

The scientific program will be carried through as accurately as possible according to the time schedule listed below. All essayists and those who are to discuss papers are urged to be on hand promptly at the time indicated, as we expect to adhere to this schedule. Each paper will be limited to fifteen minutes, to allow adequate time for questions and discussion.

PROGRAM COMMITTEE
R. S. Bromer
S. W. Donaldson
C. B. Peirce
U. V. Portmann
L. Reynolds
M. C. Sosman, Chairman

Tuesday, October 1, 1940

8:30 A.M. Call to Order, Forty-First Annual Meeting
Edward L. Jenkinson, M.D., President
Presentation of Medals and Certificates of Merit
President Jenkinson

8:40 A.M. Address of Welcome: C. Sidney Burwell, M.D., Dean of the Medical Faculty, Harvard University, Boston, Mass.

8:50 A.M. Installation of the President-Elect
Merrill C. Sosman, M.D., Boston, Mass.

Presidential Address: Specialization in Roentgenology

Symposium on Diagnosis and Treatment of Carcinoma of the Larynx

Paper No.

1. 9:00 A.M. Tomography of the Larynx. Ralph M. Caulk, M.D., Washington, D. C.
2. 9:15 A.M. Radiotherapy in Carcinoma of the Larynx. Douglas Quick, M.D., New York, N. Y.

3. 9:30 A.M. Causes of Failure Following Roentgen Treatment of Cancer of the Larynx. Maurice Lenz, M.D., New York, N. Y.

4. 9:45 A.M. Cancer of the Larynx: Surgical Treatment. LeRoy A. Schall, M.D., Boston, Mass.

10:00 A.M. Discussion:
Harris P. Mosher, M.D., Boston, Mass.
Gordon E. Richards, M.D., Toronto, Canada,
Charles L. Martin, M.D., Dallas, Texas.

10:30–11:30 A.M. Intermission to study scientific and technical exhibits.

5. 11:30 A.M. Scattered Radiation under Actual Conditions. Robert B. Taft, M.D., Charleston, S. C.

6. 11:45 A.M. A Comparison of Tissue Doses from 200 kv. and 1000 kv. Roentgen Rays Based on Ionization Measurements. Edith H. Quimby, M.A., D.Sc., New York, N. Y.

7. 12:00 M. Comparative Experimental Studies of 200 kv. Roentgen Rays. Biologic Effects on the Epiphysis, Bone Marrow and Skin of the Albino Rat. Edward M. Gall, M.D., James R. Lingley, M.D., and John A. Hilcken, M.S., Boston, Mass.

12:15 P.M. Discussion of above papers:
Richard Dresser, M.D., Boston, Mass.
Otto Glasser, Ph.D., Cleveland, Ohio.

8. 12:25 P.M. Irradiation of the Pituitary Gland in Posterior Lobe Hyperfunction Controlled by Biologic Tests. Eugene P. Pendergrass, M.D., Philadelphia, Pa.

12:40 P.M. Discussion:
John Rock, M.D., Boston, Mass.

9. 12:45 P.M. Roentgen Therapy as an Analgesic Agent. John R. Carty, M.D., and Lucille M. Bond, M.D., New York, N. Y.

1:00 P.M. Discussion:
Frederick W. O'Brien, M.D., Boston, Mass.

1:00–2:00 P.M. Lunch.

10. 2:00–3:00 P.M. Clinical Lecture: Radiosensitivity of Tumors. Shields Warren, M.D., Boston, Mass.

3:15–4:30 P.M. Instruction Courses—See Program of the Instruction Courses in the May, 1940, issue of this JOURNAL.

4:30–6:00 P.M. First executive business session of the Society.

Tuesday Evening

8:30 P.M. Introduction of Caldwell Lecturer by Percy Brown, M.D., Boston, Mass.

Caldwell Lecture—The Development of the Science of Roentgen Technique
George W. Holmes, M.D., Boston, Mass.
Presentation of Caldwell Medal to Dr. Holmes by the President

Wednesday, October 2, 1940

Symposium on Classification, Treatment and Prognosis of Carcinoma of the Thyroid

11. 8:30 A.M. Histologic Classification of Tumors of the Thyroid. Shields Warren, M.D., Boston, Mass.

12. 8:45 A.M. Carcinoma of the Thyroid: Radiation Therapy. Hugh F. Hare, M.D., Boston, Mass.

13. 9:00 A.M. Experiences at the Cleveland Clinic in the Treatment of Malignant Tumors of the Thyroid Gland. U. V. Portmann, M.D., Cleveland, Ohio.

14. 9:15 A.M. Radioactive Iodine in Thyroid Disease. Saul Hertz, M.D., Boston, Mass.

15. 9:30 A.M. The Surgical Treatment of Carcinoma of the Thyroid and Discussion of Results Following Irradiation. Frank H. Lahey, M.D., Boston, Mass.

9:45 A.M. Discussion:
Arthur C. Christie, M.D., Washington, D. C.

10:00–11:00 A.M. Intermission to study scientific and technical exhibits.

16. 11:00 A.M. The Results of Conservative Treatment in Certain Cerebral Gliomas. Edward L. Jenkinson, M.D., and Eric Oldberg, M.D., Chicago, Ill.

17. 11:15 A.M. Some Biophysical Effects of Radiation on the Brains of Experimental Animals. Lawrence Reynolds, M.D., K. E. Corrigan, Ph.D., H. S. Hayden, Ph.D., and A. J. Derbyshire, Ph.D., Detroit, Mich.

11:30 A.M. Discussion:
Gilbert Horrax, M.D., Boston, Mass.

18. 11:40 A.M. Electrosurgery in Combination with Radiotherapy in Malignant Disease. George E. Pfahler, M.D., and David A. Sampson, M.D., Philadelphia, Pa.
11:55 A.M. Discussion:
Thomas J. Anglem, M.D., Boston, Mass.

19. 12:05 P.M. Radiotherapy in Carcinoma of the Tongue. Gordon E. Richards, M.D., Toronto, Canada.
12:20 P.M. Discussion:
Grantly W. Taylor, M.D., Boston, Mass.

20. 12:30 P.M. Roentgen Treatment of Hodgkin's Disease. Frederick W. O'Brien, M.D., Boston, Mass.
12:45 P.M. Discussion:
Edward M. Gall, M.D., Boston, Mass.

1:00–2:00 P.M. Lunch.

21. 2:00–3:00 P.M. Clinical Lecture: Roentgen Rays in Veterinary Medicine. Dr. Gerry B. Schnelle, Boston, Mass.
"Experts"—Samuel W. Donaldson, M.D., Ann Arbor, Mich.
Vincent W. Archer, M.D., University, Va.
L. H. Garland, M.D., San Francisco, Calif.

3:15–4:30 P.M. Instruction Courses—For details see program in the May, 1940, issue of this JOURNAL.

Evening free for group dinners.

Thursday, October 3, 1940

Symposium on Unusual Forms of Pulmonary Disease

22. 8:30 A.M. The Significance of the Tuberculin Test in Evaluating the Early Tuberculous Lesion. T. L. Badger, M.D., and Max Ritvo, M.D., Boston, Mass.

23. 8:45 A.M. Tuberculous Mediastinitis. Chester S. Keefer, M.D., Boston, Mass.

24. 9:00 A.M. Tracheobronchial Tuberculosis. Lowry F. Davenport, M.D., Brookline, Mass.

25. 9:15 A.M. Sarcoid Disease as Revealed in the Chest Roentgenogram. Donald S. King, M.D., Boston, Mass.

26. 9:30 A.M. Incidence of Bronchomycosis in the South. Robert J. Reeves, M.D., Durham, N. C.
9:45 A.M. Discussion:
Papers 22 and 23—P. F. Butler, M.D., Boston, Mass.
Papers 24 and 25—John W. Pierson, M.D., Baltimore, Md.
Paper 26—Thomas R. Healy, M.D., Boston, Mass.

10:15–11:15 A.M. Intermission to study scientific and technical exhibits.

27. 11:15 A.M. Roentgen Kymography in Constrictive Pericarditis. Leo G. Rigler, M.D., and H. S. Friedell, M.D., Minneapolis, Minn.

28. 11:30 A.M. The Usefulness of Roentgen Kymograms in the Clinical Study of Heart Disease. Wendell G. Scott, M.D., St. Louis, Mo.

29. 11:45 A.M. An Evaluation of the Roentgen Kymogram in the Study of Diseases of the Heart and Great Vessels. Murray M. Friedman, M.D., New York, N. Y.
12:00 M. Discussion:
L. H. Garland, M.D., San Francisco, Calif.
Samuel A. Levine, M.D., Boston, Mass.

30. 12:15 P.M. Further Developments in the Cineroentgenographic Diagnosis of Pulmonary and Cardiac Lesions. William H. Stewart, M.D., H. C. Haier, M.D., and C. W. Breimer, M.D., New York, N. Y.

31. 12:30 P.M. A New Technique for the Arteriographic Examination of the Abdominal Aorta and Its Branches, Pedro L. Fariñas, M.D., Havana. Cuba.
12:45 P.M. Discussion:
C. Sidney Burwell, M.D., Boston, Mass.

1:00–2:00 P.M. Lunch.

32. 2:00–3:00 P.M. Clinical Lecture: Leukemia. William B. Castle, M.D., Boston, Mass.

3:15–4:30 P.M. Instruction Courses—For details see program in the May, 1940, issue of this JOURNAL.

4:30–6:00 P.M. Second executive business session of the Society.

Thursday Evening

6:30 P.M. Reception to members and guests by the New England Roentgen Ray Society
7:30 P.M. Annual Banquet
10:00 P.M. Entertainment and dancing

Friday, October 4, 1940

Miscellaneous Topics

33. 8:30 A.M. An Unusual Intracranial Foreign Body. Robert Drane, M.D., Savannah, Ga.

34. 8:45 A.M. Neuroblastoma. George M. Wyatt, M.D., and Sidney Farber, M.D., Boston, Mass.

9:00 A.M. Discussion:
S. B. Wolbach, M.D., Boston, Mass.
Ralph S. Bromer, M.D., Philadelphia, Pa.

35. 9:10 A.M. Polyostotic Fibrous Dysplasia. Karl Kornblum, M.D., Philadelphia, Pa.

9:25 A.M. Discussion:
Fuller Albright, M.D., Boston, Mass.

36. 9:30 A.M. Body Section Roentgenography (Planigraphy) in Diseases of the Respiratory Tract. Barton R. Young, M.D., Philadelphia, Pa.

37. 9:45 A.M. Cranial Laminagraphy. Cornelius G. Dyke, M.D., New York, N. Y.

10:00 A.M. Discussion:
Hugh M. Wilson, M.D., New Haven, Conn.
W. Edward Chamberlain, M.D., Philadelphia, Pa.

10:00–11:15 A.M. Intermission to study scientific and technical exhibits.

Symposium on Unusual Gastrointestinal Lesions and Unusual Sources of Gastrointestinal Hemorrhage

38. 11:15 A.M. Hemorrhage from Gastritis. Edward B. Benedict, M.D., Boston, Mass.

39. 11:30 A.M. Technical Problems in the Roentgenological Demonstration of Esophageal Varices. Richard Schatzki, M.D., Boston, Mass.

40. 11:45 A.M. The Rôle of Intramural Tumors and Hiatus Hernia in Gastric Hemorrhage. Aubrey O. Hampton, M.D., and Otto Sahler, M.D., Boston, Mass.

41. 12:00 P.M. Tumors of the Small Intestine. B. R. Kirklin, M.D., and Harry M. Weber, M.D., Rochester, Minn.

12:15 P.M. Discussion:
B. R. Kirklin, M.D., Rochester, Minn.
Chester Jones, M.D., Boston, Mass.

42. 12:40 P.M. The Effect of Vitamin B-Complex Deficiency on Gastric Emptying and Small Intestinal Motility. Gilbert W. Heublein, M.D., Hartford, Conn.

12:55 P.M. Discussion:
E. P. Pendergrass, M.D., Philadelphia, Pa.

1:00–2:00 P.M. Lunch.

43. 2:00–3:00 P.M. Clinical Lecture: Osteoporosis. Fuller Albright, M.D., Boston, Mass.

3:15–4:30 P.M. Instruction Courses—For details see program in the May, 1940, issue of this JOURNAL.

Final Adjournment

BULLETIN OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY

PRESENT STATUS OF RADIOLOGICAL PRACTICE*

The program committee of this Society has seen fit to place the subject of Medical Economics before you, along with the scientific discussions—an unprecedented procedure in this organization, I am sure, but one which will likely become a more common practice in medical groups in the years to come. There must be a reason for this. Are we not all beginning to feel at least a little pressure from the trend of events which threatens to change the order of our professional lives? Briefly, we might try to analyze the development of this relentless change in the social structure of this country, which of course is affecting

* Presented at the annual meeting of the Pennsylvania Radiological Society, Hershey, May 18, 1940, by J. H. Gemmell, M.D., Rochester, Pennsylvania.

individuals of all occupations and of none. For a century or more, with new frontiers to explore and with an apparently endless supply of resources, this nation progressed to an all time high among civilizations in respect to national prosperity and a high average standard of living, under a system fostering capitalism and individual enterprise. Not that such a system was without its brutal abuses—many a group was left gasping by the wayside. At any rate, approximately contemporary with that other War, there began to creep in those tendencies of strong European flavor, with rapid acceleration of the pace in the past seven years. Whether of necessity a civilization, in aging a little, or upon finding its frontiers less expansive, inevitably drifts toward a more rigid socialistic control, or whether the abuses of our past hastened the issue, is beside the point. We still have private enterprise in these United States, but there is enough trouble brewing to run many a rugged individual ragged, and there will be no let-up after November of this year, regardless of whatever type of Deal comes after that.

It has not been my experience, until the past year or two, to have been more than dully aware that important changes were occurring involving medical practice. Perhaps the proposed Wagner Act last year made us realize more than anything else what might happen, and that we shall be beset by other "Wagner" Acts is an accepted fact.

Without trying to imagine the confusion which may yet be in store for all physicians, let us confine this discussion mainly to a consideration of the present status of radiological medical practice. Included in the source of material for this exposition are bulletins and pamphlets received from Mac Cahal of the Inter-Society Committee for Radiology, among which was the very thorough and exhaustive report of the Chairman of the Board of Chancellors of the American College of Radiology, presented at the February, 1940 meeting. In this 27-page report Dr. Chamberlain devotes much space to what he calls "An Economic Inventory of Radiology." Naturally this is a competent treatise on the subject at hand and should certainly be made available to anyone interested.

It would be impractical for me to discuss fully all the problems that confront us, so I have chosen to lay emphasis on several topics which have seemed of particular importance, and will offer my viewpoint in a more or less informal way.

1. *The System of Remuneration for Radiologists.* Aside from the radiologist with the private office, who collects his fees on the conventional fee-for-service basis, a large share of this work is done in hospitals, where the usual financial arrangements consist of a straight salary, a salary plus commission, percentage of gross or net income, or a rental basis. Now a point which has always interested me is the contention that "the best interests of the public will be served and the continued progress of the science of Radiology will be assured if this specialty is practiced on a fee-for-service basis, under which financial rewards to the practitioner are determined by ability, industry, and ambition." By implication this is critical of the straight salary system. But let us face the facts. There are many physicians, radiologists among others, in Public Health Service, on the staffs of tuberculosis, mental, or city charity institutions, whose incomes are derived from public funds, almost necessarily a salary proposition; no question of an unsound policy arises there. The staff members of the Mayo Clinic and other similar groups are paid salaries, but it is my understanding that a form of partnership is established, giving the individual physicians certain control of their income. Many of our most able radiologists in large institutions, on a full time basis, are perfectly satisfied with their salaries because they are adequate. Some radiologists may be dissatisfied with their salary arrangement, but feel helpless to effect a change. The Code of Ethics of the American Medical Association provides that: "It is unprofessional for a physician to dispose of his

services to any lay body, organization, group of individuals,—under terms or conditions which permit a direct profit from the fees, salary, or compensation received to accrue to the lay body or individual employing him ...." It is obvious, of course, that under any established straight salary plan, a hospital might profit considerably on the roentgen department during busy times, and actually lose in a slow period, the latter being an extremely unusual occurrence, I am sure. Perhaps less frequently, but certainly a distinct possibility, a hospital may profit from roentgenological services where the radiologist is paid an inadequate percentage of the gross or net income. Another item among these hospital-radiologist relationships is the usual but dubiously sound policy of having the hospital collect the fees. Perhaps the foregoing may seem to be inconsequential and unimportant, for who among you are now particularly interested in how you are paid, rather than in how much. Nevertheless, the future may make the "how" seem of greater importance, and if it becomes so, then the how much will be less than it was. One more remark or two along this line. We still see retention of the fee-for-service idea in many walks of life,—the legal profession, many individual business enterprises, and even the most competent salesmen in large department stores are partially on a commission basis. And we cannot overlook the vast majority of medical practitioners, both general and those in most specialties, whose collective enterprise has helped to raise the general status of American medicine so high. It has occurred to me that it is the competitive influence of this large group which has so far served to keep bolstered up the economic standards of those not strictly in private practice. Do any of you believe that if all medical practice were to be suddenly institutionalized under lay management, on a similar basis to that of a radiologist on salary, the total net income of all physicians would be what it is now? It may be of some interest to recall that in the survey conducted by the Medical Economics Committee of this Society last year, Pennsylvania radiologists on a salary at hospitals declared average incomes 45 per cent less that those of radiologists on a commission basis.

II. *Defections in Our Own Ranks.* A. Fee-splitting: I do not happen to know directly of any of this practice among radiologists in my community, but in a large Eastern city ten years ago it was not unusual to hear of a physician getting a percentage from the radiologist for doing a gastrointestinal series, or some other procedure. It was even common enough to hear of a physician referring a patient to an abortionist for a very substantial cut on the fee.

I believe the origin of this vicious practice lies within the profession itself, and its solution, if any, must emanate from the same source. The prize example of a situation which propagates this tendency is that of a general practitioner referring an appendectomy case to a surgeon. Under ordinary circumstances, the general physician may get a $3 fee for the house call, and the surgeon will collect $100 or more for the operation. The temptation to maneuver this discrepancy in fees surreptitiously is a great one, but why should there not be an open and above board method of indicating to the patient the actual distribution of medical costs, either on the same or on separate billheads. In the above illustration, if the total medical fee is to be $103, obviously the general practitioner is not getting a just return for his responsibility in the case, and it is up to the medical participants to develop an equitable adjustment. The public would soon learn to cooperate in such an arrangement, if the physicians would cooperate in establishing it.

Other types of fee-splitting amount to no less than petty racketeering. If a radiologist can afford to divert $5 of a total $20 fee back to the referring physician, then he is charging too high a fee, and the patient should get the benefit of the $5 reduction.

B. Rigid and excessively high fee sche-

dules: I believe that radiologists are less frequently offenders in this respect than physicians in other specialties. It may be difficult to define what an excessively high fee is, but I am convinced that such practices by the few have been one of the important stimuli to the recent agitation for medical regimentation with which we are threatened. One personal experience along that line was the consultation of a "cancer specialist," not a radiologist, on a case of advanced carcinoma of the lung. The consultation fee was $150 for about one and one-half hours' conference with attending physicians and family, and at most a total loss of time of four hours. Ethically there was nothing else to complain about, there being complete accord between consultant and attendants as to treatment, prognosis, and even the diagnosis. The family of the patient was in very modest circumstances. Incidentally, the other medical fees in the case, including the radiological and that of the internist for the next several weeks until death, totaled about $95.

But the day of the physician, who is in the habit of charging all the traffic will bear, is inevitably drawing to a close. And rightly so, for then the majority will no longer receive the general criticism of exorbitance, for which the few are responsible.

C. Failure of radiologists to personalize their practice with clinical observation and personal contact with the patient: The nature of diagnostic radiology is such that circumstances are frequently present to bring this about. No doubt we might do better if we could personalize our entire practice, instead of so often depending on a brief word from the referring physician. Unquestionably our lack in this regard has fostered such unpleasantries as the division of diagnostic roentgenology into technical and professional phases.

III. *Competition Problems.* A. The general practitioner with a roentgen-ray unit but no special qualifications in roentgenology: In a certain few communities where there is no qualified roentgenological service within reasonable range, there is probably a real need for this. However, the general man will get very little referred roentgen-ray work from his competitors in general practice, if there is available an experienced roentgenologist, capable of doing superior work.

B. The lay roentgenographer: In a few localities this has been a troublesome problem, but here again, if a roentgenologist is worth his salt, the increased value of his services will eventually merit the entire support of the medical profession. I understand this is not a very serious difficulty throughout the country as a whole.

C. Other medical specialists with roentgen-ray units: In most instances of this sort I am sure competition is entirely fair. What fault should we find with an orthopedic surgeon or urologist who wishes to have roentgen-ray service in his own office, necessarily assuming that he has become qualified in interpreting his results?

D. Cut rate competition among radiologists: This procedure has more serious ultimate implications than any of the foregoing, and it is up to the individual offenders to desist.

E. Commercialized mass chest surveys: In certain communities, the Powers Film Company has brought in a portable roentgen-ray machine to schools or factories and made examination, for a dollar fee, of large groups of individuals, on rolls of paper film. This is done under the auspices of local tuberculosis associations, of industrial organizations, etc. In my county, the Tuberculosis Association has sponsored this for the past six or seven years. My predecessor did not wish to have anything to do with it and for a while the films were sent to Harrisburg to one of the personnel in the State Tuberculosis Association, for interpretation. For the past several years I have taken over the interpretation for a very small fee per film, more to keep that part of it a local matter than for any other reason. Aside from any discussion of the merits of this type of examination, which in my opinion is well worth the dollar, I think the

unfortunate thing about these surveys is that in most instances it is not the radiologist who is sponsoring them. If there is an established need for mass chest roentgenography at low cost, perhaps we ought to be operating these plans ourselves, because we eventually have to read the films anyway. All the Pittsburgh men are familiar with the situation that originated there last fall. A demand for chest examination of certain school groups arose, and the local radiologists blocked the influx of the Powers Company by taking over the work themselves, assigning different groups to the various men at their offices or hospitals. Using celluloid film and lacking "mass production" facilities, this is not a practical procedure, and I wonder if there is not some other answer to it. The apparent demand for this sort of thing in the Pittsburgh district alone would probably warrant the purchase of a portable roentgen-ray unit, truck, rolls of paper or celluloid film, by a group of radiologists, who could then arrange for the technical help and be in entire control of the whole situation. It is also possible that the method of roentgen-photography may prove to be a very satisfactory means of conducting low cost mass surveys, because of the very low material cost.

F. Governmental and other clinics: We are all familiar with the activities of clinics of various types in our own communities, and it is easy to foresee what might happen to private medical practice if present tendencies toward governmental invasion of additional fields of endeavor transpire. The 1939 Inter-Society Committee for Radiology report warns of the possibility, for example, of establishment of cancer clinics for diagnosis and treatment. The National Cancer Institute, a division of the Public Health Service, is entirely a research organization now, but there is a proviso in the new Wagner Health Bill for 500 diagnostic centers, at a cost of $30,000 each, and in the National Health Program are recommendations for an annual expenditure of $25,000,000 for "cancer control."

G. There are other existing types of competition affecting roentgenological practice, such as industrial clinics and certain insurance schemes, which we shall not take up here.

IV. *Group Hospitalization.* In a general way, I do not believe anyone can deny the merit of this rapidly growing movement, if one is to approve of the insurance idea at all. It is unquestionably a sound policy to carry life insurance or to have fire insurance on your home, so why would it not be equally advantageous for an individual to prepay a portion of his health risk, to safeguard against a possibly calamitous hospital bill. Unfortunately, most of these hospitalization plans have incorporated certain features considered objectionable by the medical profession. In the main, it is the inclusion of medical services which precipitates most of the controversy—radiology, anesthesia, and pathology being generally involved. Apart from the ethical consideration of the sale of medical services, let us analyze the probable viewpoint of the radiologist from the financial angle. If he is on a straight salary or on a full time percentage basis, he is not affected; if he has a private office he may be affected, if subscribers are referred to a hospital solely for diagnostic purposes. In certain hospital service plans, this is part of the contract, in others "free x-rays" are advertised, and in still others x-rays "incident to hospitalization" may be subject to a various interpretation. Thus far, I suppose the average radiologist has gained as much financially as he has lost through group hospitalization, so that ostensibly the ethical principles must be the important factor in efforts to delete medical services from these plans. And radiologists and pathologists are not alone in these efforts; organized medicine as exemplified in the American Medical Association has unreservedly taken the same stand. The reason is obvious. Other medical groups are beginning to realize that medical services other than those mentioned may yet be included in group hospitalization plans, as indeed they

already are in certain localities. Dr. Chamberlain devoted about seven pages of his February report to a discussion of the ambitions of hospital plan executives in respect to enlarging the scope of medical services to be sponsored by hospitals. One of these authorities proposed at the last annual meeting of the American Hospital Association in Toronto that hospitals establish faculties of doctors with definite salaries as a means to combat socialized medicine.

As for the Hospital Service Plans in force in Pennsylvania, radiology, pathology and anesthesia were included in the contracts, presumably with the tacit approval of certain medical officials of the State Medical Society. And the seeds of ambition have apparently sprouted in the organization back of these plans. About three weeks ago, the Pennsylvania Hospital Association sent a form letter to the Board Members of all participating hospitals, suggesting that there had been a "demand" for other medical services to be included in the contracts.

V. *Progressive Changes Sponsored by the Medical Profession.* According to present indications, all physicians may experience sometime in the future drastic changes in their economy. We are pitted against the forces of public opinion, developed principally by certain socialistic minded and political groups, who contend that we are horse and buggy doctors obstructing progress. On the other hand, with the exception of a minor but influential few, the majority of us feel that the existing system has fostered a progress which indicates that American medicine is second to none in the world, and that the good in it should be retained. Just because our system is imperfect in certain details, why should it be necessary to have a wholesale substitution of it by a system hampered with lay and political control.

Now what is organized medicine doing to forestall the approach of undesirable policies or to alter the objectionable features of existing developments? It goes without saying that our present dilemma would be less acute if the medical profession had displayed awareness of these many problems at their inception years ago. I believe, for example, that hospital-physician relationships would be essentially tranquil today had all physicians maintained an active participation in hospital management from every standpoint, and unquestionably the patients would have benefited too. Also, the profession might have done well to maintain an alert, politically minded representation, which could have insisted on having a voice in any projected civic or governmental enterprise involving medical practice. There are already signs of much activity cropping out among medical groups in various parts of the country. One movement of apparent particular importance is that of Voluntary Medical Service Insurance. These are nonprofit plans controlled by physicians, inaugurated to avoid possible similar systems sponsored and operated by political groups. Now there is no certainty that these plans will be generally successful, because the policies will be expensive enough to repel certain individuals in the income levels they are designed to serve. Very possibly many of these will prefer to take their chances on good health than make a regular prepayment, frequently without return in services, and of course, some of these individuals customarily default on their medical bills anyway, under the present system. Nevertheless, I believe that vigorous efforts should be made to promote the success of such insurance ideas, because if they then fail, at least our sincere attempts will have demonstrated to political schemers that the population does not "voluntarily" want these things.

In California a medical service plan is in operation now, backed up almost 100 per cent by the physicians; it is my understanding that physicians also have control of the hospitalization insurance, and that the two types of policies are frequently sold to groups together. In Michigan the group hospitalization organization is separate from the medical service organization

but the two work closely together, and indeed have offices in the same building. The fomer of the two has been in operation for some time and its officials originally intended including radiology, anesthesia, and pathology in their plan, but the medical profession was insistent on deletion of these medical services, and were successful. Their medical service insurance is just beginning to function now on a limited scale, and the three specialties just mentioned are to be given consideration equal to that of all other services, whether a patient is in or outside the hospital. You are all undoubtedly familiar with developments along this line in Pennsylvania. The Voluntary Insured Medical Service was finally approved by action of the State Society House of Delegates, February 28, 1940, and operative details are now being worked out before offering the policies to the public. As you know, fifteen representatives of the three radiological societies of this state met in Philadelphia on December 2, 1939, from which emanated a 13-page report carrying recommendations in regard to the new plan. Copies of this report were sent to the proper committees of the State Medical Society, and I believe it contributed a definite effect on the final result of their deliberations. Unfortunately, we were not at this time able to obtain coverage for radiology where persons have that coverage under their group hospitalization policies, although efforts were made in that direction.

In addition to the above mentioned programs, organized medicine is showing much more activity in the various phases pertinent to medical economics. You have now only to read almost any of our scientific publications and see considerable space devoted to the subject. Strong efforts are being made to build up influence with political forces so that our viewpoints may get fair consideration. All of us have received many letters, pamphlets, and requests for support from the National Physicians Committee, which began active operation about eight months ago. Apparently this is a step in the right direction and warrants at least a careful appraisal.

As radiologists, I think we may be justly proud of our local, sectional, and national organizations. Each of these offers splendid facilities for continued progress in our qualifications. The combined efforts of the several national organizations resulted, seven years ago, in the American Board of Radiology, an important step forward. Since 1935 the American College of Radiology has made significant advances, and the recent opportunity offered us to affiliate with that body should serve to unite our entire forces into an intelligent unit, capable of great good.

A word should be said about us as individuals. It is up to us to do the best we can professionally in our own communities, both in our work and in our contacts with medical confrères and institutional associates. For we have continually to show proof of our worth, and by so doing, we are enabled to solve many of our local difficulties satisfactorily. We should and must support our regional and national organizations, for their aims are high in setting up educational standards and in attaining an establishment of a more ideal economy. But we should not expect nor would we want these organizations to become so powerful that hospitals, for example, would be forced to keep us around just because of our membership in Medical Union No. X.

In conclusion, let us have trust that our economic difficulties may never be more serious than suggested in this report. In the light of these amazing world events, this is perhaps too much to expect, but we all can at least try to preserve the better things in our American Way of Life.

AMERICAN RADIUM SOCIETY

The Twenty-fifth Annual Meeting of the American Radium Society was held at the Hotel Waldorf Astoria, New York City, on June 10 and 11, 1940, under the presidency of Dr. Lawrence O. Pomeroy. The meeting was a well attended one and much interest

was shown in the papers presented. The scientific program was as follows:

Presidential Address. Lawrence A. Pomeroy, M.D., Cleveland, Ohio.

The Need for Clinical Classification of Cancer. Peter A. Nelson, M.D., and Herbert E. Schmitz, M.D., Chicago.

Treatment of Large Subcutaneous Hemangiomas with Removable Platinum Implants. Milton Friedman, M.D., New York City.

The Radium Treatment of Angiomas. Frank E. Simpson, M.D., and J. Ernest Breed, M.D., Chicago.

Pulmonary Lesions in the Lymphomas. Lloyd F. Craver, M.D., New York City.

The Treatment of Leukoplakia Buccalis and Related Lesions with the Sex Hormones. Ira T. Nathanson, M.D., and David G. Weisberger, M.D., Boston.

Carcinoma of the Penis. Louis H. Jorstad, M.D., St. Louis.

The Treatment of Cancer of the Rectum. George S. Sharp, M.D., Pasadena, California.

The Treatment of Cervical Metastatic Cancer. Hayes E. Martin, M.D., New York City.

Complications Following Irradiation of Breast Cancer. Joseph H. Farrow, M.D., New York City.

Irradiation Pulmonary Fibrosis. Bernard P. Widmann, M.D., Philadelphia.

The Surgery of Post-irradiation Necrosis. Ernest M. Daland, M.D., Boston.

Cancer of the Stomach in the Young. Gordon P. McNeer, M.D., New York City.

Failures in Radiotherapy for Uterine Bleeding and Fibromyomata. James A. Corscaden, M.D., New York City.

Comments on the Treatment and Sequelae of Carcinoma of the Uterus. Elizabeth Newcomer, M.D., Denver, Colorado.

Carcinoma of the Uterine Cervix Treated with 400 kv. Roentgen Rays and Radium. John T. Murphy, M.D., and C. E. Hufford, M.D., Toledo, Ohio.

Analysis of 700 Cases of Carcinoma of the Cervix. Harold G. F. Edwards, M.D., Shreveport, Louisiana.

The Salvage in Vulvar and Cervical Cancer with Lymph Gland Metastasis. Fred J. Taussig, M.D., St. Louis.

Carcinoma of the Cervix Uteri in Childhood and Adolescence. Harry H. Bowing, M.D., and J. A. L. McCullough, M.D., Rochester, Minnesota.

The Progress of Radium since its Earliest Therapeutic Availability. Albert Soiland, M.D., Los Angeles.

Radium Beam Therapy. Ira I. Kaplan, M.D., New York City.

The Experimental Modification of the Sensitivity of Yeast to Roentgen Rays. Robert S. Anderson, Ph.D., New York City.

The Influence of Radiation and Hibernation on Growth Behavior of Mouse Neoplasms. Henry J. Ulmann, M.D., Fritz Bishop, and Louisa Long, Santa Barbara, California.

Some Considerations Regarding Induced Radioactivity. G. N. Glasoe, New York City.

The Significance of Specific Ionization in the Biological Action of Various Radiations. Raymond E. Zirkle, Bryn Mawr, Pennsylvania.

Protection of Personnel against Wide Therapy Beams of Roentgen Rays and Gamma Rays. T. R. Folsom and B. Focht, New York City.

On Monday afternoon at four o'clock the Janeway Lecture was given by Dr. Edith H. Quimby of the Memorial Hospital, New York City, the title being "The Specification of Dosage in Radium." As would be expected, this was a very scholarly, clear and concise exposition of an immensely practical subject.

The Annual Banquet was held on Monday evening in the Sert Room of the Hotel Waldorf Astoria. This was a gala occasion with many members and guests present. At the end of the dinner the Janeway Medal was presented to Dr. Edith H. Quimby. The remainder of the evening was given over to music and dancing.

On Wednesday afternoon the Society was invited to the new Memorial Hospital for a "Demonstration and Round Table Discussion on Radium and X-ray Apparatus." The meeting was held in the auditorium with Dr. Hayes E. Martin as Chairman. Dr. Rhoads, the Superintendent of the Hospital, made the opening remarks after which the following subjects were discussed briefly by members of the Hospital Staff:

Radium Applicators for Rectal Cancer. George E. Binkley, M.D.

Radium Applicators for Gynecologic Cancer. William P. Healy, M.D.

Radium and X-ray Applicators for Head and Neck Cancer. Hayes E. Martin, M.D.

Demonstration of Physical Measurements of Induced Radioactivity. L. D. Marinelli, M.D.

Equipment for the Preparation and Handling of Radon Applications, Adjustable Diaphragm for Roentgen Therapy. Edith H. Quimby, D.Sc.

Time was then given for an inspection of the various apparatus which had been discussed, following which a brief period was taken up with questions concerning the apparatus and their application. The formal meeting was then adjourned and an inspection tour was made of the out-patient clinics and the department of radiology. This new Memorial Hospital is excellently planned and equipped and most attractively constructed. It was a great privilege to be able to visit this institution which represents the best that America has to offer in the research of the many problems connected with cancer and in its therapy.

Those who were in charge of the arrangements for the meeting of the American Radium Society should feel gratified and are to be congratulated upon the general excellence of the scientific program and the social functions held in connection with it. The 1941 meeting of the Society will be held in Cleveland at a time and place to be announced later.

EDITH H. QUIMBY HONORED

Edith H. Quimby, well known physicist of the Memorial Hospital, New York City, had conferred upon her the honorary degree of Doctor of Science by her Alma Mater, Whitman College, Walla Walla, Washington, on June 3, 1940.

Another deserved honor was bestowed on Dr. Quimby when she was invited to give the Janeway Lecture, which she delivered before the American Radium Society on June 10, 1940. At the banquet on the same evening she was presented with the Janeway Medal.

The staff of Memorial Hospital, of which she has been a member for twenty years, as well as radiologists both in America and abroad, are justly proud of Dr. Quimby, her achievements and the honors which have been conferred upon her.

EXAMINATION FOR APPOINTMENT AS COMMISSIONED OFFICERS IN THE MEDICAL CORPS OF THE U. S. NAVY

The next examination for doctors of medicine desiring to enter the Medical Corps of the United States Navy will be held on August 19, 1940, at the following Naval Medical Department activities:

U. S. Naval Hospital, Chelsea, Massachusetts.
U. S. Naval Hospital, Brooklyn, New York.
Norfolk Naval Hospital, Portsmouth, Virginia.
U. S. Naval Hospital, Pensacola, Florida.
U. S. Naval Hospital, San Diego, California.
Naval Medical Center, Washington, D. C.
U. S. Naval Hospital, Newport, Rhode Island.
U. S. Naval Hospital, Philadelphia, Pennsylvania.
U. S. Naval Hospital, Charleston, South Carolina.
U. S. Naval Hospital, Great Lakes, Illinois.
U. S. Naval Hospital, Mare Island, California.
U. S. Naval Hospital, Puget Sound, Bremerton, Washington.

Graduates of Class "A" medical schools who have had an internship in a civilian hospital and who are physically and professionally qualified may be commissioned in the permanent Medical Corps of the Navy as Assistant Surgeons with the rank of Lieutenant (junior grade). Applicants must be less than thirty-two (32) years of age at the time they receive their commissions, citizens of the United States, physically qualified for appointment as officers in the Medical Corps and must demonstrate their professional qualifications by competitive written, oral and practical examinations. The professional examination will embrace the subjects of: (1) general medicine; (2) general surgery; (3) obstetrics and gynecology; and (4) preventive medicine and medical jurisprudence.

The pay and allowances for Assistant

Surgeons with the rank of Lieutenant (junior grade) in the Medical Corps of the Navy is $2,699 per year if the officer has no dependents, and $3,158 per year if he has dependents.

Additional information regarding physical requirements, etc., may be obtained by addressing a letter to the Bureau of Medicine and Surgery, Navy Department, Washington, D. C. Applications must be completed and received in the Bureau of Medicine and Surgery prior to August 1, 1940, in order that authorization may reach the applicant in sufficient time for him to appear for examination on August 19, 1940.

MINNESOTA RADIOLOGICAL SOCIETY

The Minnesota Radiological Society held its Twelfth Annual Meeting in Rochester on April 23, 1940. Dr. Bernard H. Nichols of Cleveland, Ohio, delivered the Carman Lecture before the Minnesota State Medical Society, the title being "Indications for the Use of Excretory Urography in Diagnosis." At the dinner and business meeting in the evening Dr. Nichols addressed the Society on "The Future of Radiology." The following officers were elected for the coming year: *President:* Harry M. Weber, Rochester; *Vice-President:* G. T. Nordin, Minneapolis; *Secretary-Treasurer:* J. P. Medelman, St. Paul.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The annual meeting of the Pennsylvania Radiological Society was held at the Hotel Hershey, Hershey, Pennsylvania, on May 17 and 18, 1940. In addition to the two-day scientific program, consisting of papers and exhibits by members of the Society, Dr. W. Edward Chamberlain of Philadelphia gave an excellent talk on "Fractures." Another interesting feature of the meeting was a paper by Dr. B. P. Widmann of Philadelphia on "Massive Dose Roentgen Therapy of Superficial Cancers."

SOUTH CAROLINA X-RAY SOCIETY

At the annual meeting of the South Carolina X-Ray Society held in Charleston on May 1, 1940, the following officers were elected for the coming year: *President:* Malcolm Mosteller, Columbia; *Vice-President:* W. S. Judy, Greenville; *Secretary-Treasurer:* T. A. Pitts, Columbia.

MIDSUMMER RADIOLOGICAL CONFERENCE

The Sixth Midsummer Radiological Conference in the Rocky Mountains will be held in Denver, Colorado, August 8, 9 and 10, 1940, with headquarters at the Hotel Shirley Savoy. The following guest speakers have accepted an invitation to appear on the program: Lewis Allen, M.D., Kansas City, Kansas; Fred E. Angle, M.D., Kansas City, Missouri; Howard P. Doub, M.D., Detroit, Michigan; Edwin C. Ernst, M.D., St. Louis, Missouri; Howard B. Hunt, M.D., Omaha, Nebraska; Charles L. Martin, M.D., Dallas, Texas; Albert Soiland, M.D., Los Angeles, California.

There is no registration fee. A complete program may be obtained by addressing the Chairman of the Publicity Committee, Dr. L. G. Crosby, 366 Metropolitan Building, Denver, Colorado.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

The Twenty-sixth Annual Meeting of the Radiological Society of North America will be held in Cleveland, Ohio, December 2 to 6, 1940. The headquarters will be the Statler Hotel.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

A BIBLIOGRAPHY OF THE WRITINGS OF HARVEY CUSHING: Prepared on the Occasion of his Seventieth Birthday April 8, 1939, by the Harvey Cushing Society. Cloth. Price, $5.00. Pp. 108. Springfield, Illinois: Charles C Thomas, 1939.

This record of 108 pages prepared on the occasion of Harvey Cushing's seventieth birthday, April 8, 1939, by the Harvey Cushing Society, tells the story of his professional and scientific life, as completely as anyone's can be recorded by the bare statement of facts.

But consider for a moment what this book contains. First, it was prepared by a Society whose main purpose is to honor his name and accomplishments. Second, in it are recorded the pertinent data concerning his life, degrees, honors, and society memberships. Third, it contains a compilation of the titles of 319 of his published books, monographs, addresses and papers, and 328 additional publications which were written by associates in his clinics and laboratories. And, finally, there is given a list of the names of his neurosurgical assistants, among whom are some of the most distinguished neurosurgeons of Europe and the United States, many of whom now occupy important academic positions, and in addition the names of the appointees at "Old Hunterian" at the Medical Department of Johns Hopkins University, as well as the Arthur Tracy Cabot Fellows in charge of the laboratory of surgical research at Harvard, and others who were assistants in the surgical laboratory of the Peter Bent Brigham Hospital. What better criteria can be relied upon to determine, even at such an early date after his death, his real place in the history of medicine. The unadorned record of the varied achievements of a great man, without embellishment, stands alone as eloquent testimony of his true eminence in the present generation, and doubtless for all time.

The record shows that he was born in Cleveland in 1869, and lived for a period of seventy years; that he was the fourth generation of a distinguished family of physicians and medical teachers; and that he was a product educationally of Yale University (A.B.), Harvard Medical School (M.D.), and the Massachusetts General Hospital (House Officer). He was a member of the staff of the Johns Hopkins Hospital and Medical School for sixteen years at which time he came under the masterful influence of Halsted, Osler and Welch. During this period he was, at intervals, a student of Theodore Kocher and Hugo Kronecker of Bern and Charles Sherrington in Liverpool. From 1912 to 1932, an interval of twenty years, he served as the Mosely Professor of Surgery at the Harvard Medical School and Surgeon-in-Chief of the Peter Bent Brigham Hospital. Upon attaining the retiring age of sixty-two years, which is mandatory at these institutions, he became the Sterling Professor of Neurology at Yale University until 1937, at which time he turned to one of his major interests, the History of Medicine, and became the Director of studies in this subject at this same institution.

To attempt an analysis of the bibliography of Harvey Cushing would be an absorbing and stimulating task which his biographer will present adequately at some future day. The temptation cannot be resisted, however, of recording a few superficial observations of this fascinating record. The earliest indication of his interest in neurological surgery is to be found in the second paper written by him which appeared in the *American Journal of Medical Sciences* for June, 1898, when he was twenty-nine years of age. It had the title of "Haematomyelia from gunshot wounds of the spine. A report of two cases, with recovery following symptoms of hemilesion of the cord." A preliminary report dealing with this material had been presented by him before the Johns Hopkins Medical Society on May 3 of the preceding year, and this had been published in the August-September number of *Johns Hopkins Hospital Bulletin* for 1897. Doubtless it was one of these cases to which Dr. Cushing referred when he once told the reviewer that "it was the act of a jealous husband who shot his wife in the neck, with the resultant neurological pathology which stimulated my interest in neurosurgery."

His first paper dealing with extirpation of the

gasserian ganglion was published in 1900; two years later he recorded his ninth; and one year following this his thirteenth case in which this operation was performed. In 1904 appeared his initial publication dealing with the surgical removal of a brain tumor at which time he was thirty-five years of age. Two years later, his first article pertaining in any way to the pituitary body appeared in the *Journal of Nervous and Mental Diseases* with the title "Sexual infantilism with optic atrophy in cases of tumor affecting the hypophysis cerebri."

His initial historical presentation entitled "Hallen and his native town" was published in 1901, at which time Dr. Cushing was thirty-two years of age and had been at Johns Hopkins Medical School for five years. He acknowledged recently, in a letter to a friend in December, 1938, his debt to William Osler for his interest in the historical aspects of medicine, in which he stated that any interest he had in the cultural side of medicine should "properly be accredited to Osler who was the *fons et origo* of all such things during my preceding period at the Johns Hopkins Hospital."

Although Dr. Cushing is known primarily as a neurosurgeon, this bibliography reminds us that the internists should acknowledge the fact that it was he who brought a Riva-Rocci blood pressure apparatus from Italy in 1901, and published his first paper on arterial tension in 1903, which marks the beginning of blood pressure determinations in this country.

C. C. Sturgis

Endocrine Gynecology. By E. C. Hamblen, B.S., M.D., F.A.C.S., Associate Professor of Obstetrics and Gynecology, Duke University School of Medicine; Gynecologist in charge of the Endocrine Division and Sex-Endocrine Clinic, Duke University Hospital, Durham, North Carolina. Foreword by J. B. Collip, M.D., Gilman Cheney Professor of Biochemistry and Pathological Chemistry, McGill University, Montreal. Cloth. Price, $5.50. Pp. 453, with 169 illustrations. Springfield, Illinois: Charles C Thomas, 1939.

In his preface the author states that the original purpose in collecting the material presented was the organization of a series of lectures on endocrine gynecology for his classes of medical students. This makes the book valuable for the general practitioner for it presents the basic facts necessary for the practice of endocrine gynecology. It also presents valuable data for the treatment of conditions encountered in this field. Particularly valuable to everyone, be he gynecologist, internist, or general practitioner, is the specific way in which the treatment of various gynecologic conditions is outlined. The various commercial preparations recommended are those which the author himself has employed extensively and found useful. He gives the source of the commercial endocrine products as well as the various dosages available.

The book is divided into three parts:

Part I. Sex-Endocrine Principles.

Part II. Gynecic Physiology.

- Gynecic functions of maturity. The menstrual and gestational cycles.
- Physiology of sexual regression: The climateric.

Part III. Endocrinopathic Gynecology.

- Diagnostic procedures in endocrine gynecology.
- Sex-endocrine syndromes.
- Abnormalities of growth and sexual differentiation.
- Functional irregularities of uterine bleeding.
- Abnormal symptomatology of the menstrual cycle.
- Endocrine aspects of functional sterility.
- Endocrine aspects of abnormalities of gestation.
- Complications of the climateric.

In Chapter I is given a brief chronological summary of the outstanding historical discoveries in the endocrine field. The sex-endocrine principles are briefly but adequately outlined.

The chapter on growth, development and adolescence is very extensive and contains tables of normal growth. Drawings of normal osseous development at different age levels are also given.

The various gynecologic endocrine disturbances are thoroughly covered.

The general practitioner, gynecologist and endocrinologist will find this a very valuable book. The bibliography is a large one, including over a thousand references. An extensive author and subject index is included. The illustrations are numerous, including four beautiful color plates.

The author is to be congratulated on the fine way in which he has covered the extensive literature and put to practical use the clinical

and experimental data in this ever-changing and interesting field. Common sense prevails throughout the book, as well as conservatism in the interpretation of the results of endocrine therapy. For example (p. 315) he says, "Despite varying reports to the contrary, the author has encountered no definite evidence that follicle stimulation, ovulation, or the formation of corpora lutea in the human ovary resulted from treatments with *gonadotropes from the urine of pregnancy or of placental origin*."

The book is highly recommended.

ROBERT C. MOEHLIG

THE ELECTROCARDIOGRAM AND X-RAY CONFIGURATION OF THE HEART. By Arthur M. Master, B.S., M.D., F.A.C.P., Associate in Medicine and Chief, Cardiographic Laboratory, the Mt. Sinai Hospital, New York: Associate in Medicine, the College of Physicians and Surgeons, Columbia University, New York. Cloth. Price, $6.50. Pp. 222, with 71 illustrations. Philadelphia: Lea & Febiger, 1939.

The application of roentgenology and electrocardiography as an aid in the diagnosis of heart disease began about the same time. It is probable that their greatest aid in clinical cardiology has been to enable physicians to better appreciate the normal physiological mechanism of the heart. Their usefulness in the diagnosis of heart disease will vary with the knowledge and experience of the examiner. In this monograph the author's primary purpose has been to increase the accuracy of interpretation of the electrocardiogram by emphasizing factors heretofore not too well appreciated; namely, "age, body position, habitus, obesity, pregnancy, hypertension, valvular disease, congenital heart disease, pulmonary disease and deformities of the chest which alter the contour of the heart." In this he has succeeded admirably.

The subject matter is presented in the form of an atlas. Both the roentgenogram and electrocardiograms of an illustrative case are placed on the same page. The illustrations are large and of excellent quality. The three standard limb leads and a chest lead accompany each roentgenogram and occupy one page. On the adjacent page are brief clinical notes, a reading of the roentgenogram and pertinent comments upon the electrocardiographic pattern. A brief discussion introduces each chapter with comments that add to the continuity of the subject matter. The bibliography is not comprehensive but good subject and author indexes are present.

No attempt has been made to add to the criteria of interpreting the roentgenogram. The roentgenographic illustrations are used for the purpose of visual correlation, which the author says in the preface he has used successfully in a long teaching experience. Furthermore, he points out that the illustrations are examples of what does occur and are not to be accepted in a statistical sense.

This excellent book is a worthwhile contribution to the study of the physiology of the heart. Those who become familiar with its contents will add to their accuracy in interpreting the electrocardiogram.

ROBERT P. BALL

LA ROENTGENCHIMOGRAFIA CARDIO-VASCOLARE. By Prof. Pietro Perona, Incaricato di Radiologia nella R. Universita di Padova. Paper. Price, 60 lire. Pp. 356, with 169 illustrations. Belluno: Casa Editrice Libraria A. Salvador, 1939.

This book, to which Professors Gasbarrini and Maragliano have written prefaces, is properly divided into two parts. The first considers the normal physiology of the heart and the clinical methods of studying this organ, especially the roentgenologic methods of studying its function. In the second part, a study of kymography is presented, and in it are illustrated kymograms of the normal heart and great vessels. Then there follows a discussion of the roentgen kymographic findings in pericarditis, valvular diseases, myocarditis, the arrhythmias, vascular lesions in hypertension and in cases of foreign body in the heart. The presentation of the material and the illustrations are excellent. There is a bibliography of twelve pages (about 300 references). This monograph will serve to evaluate and to popularize the method of roentgen kymography.

E. T. LEDDY

A MANUAL OF ROENTGEN DIAGNOSIS. By Kenneth S. Davis, M.D., Los Angeles. Cloth. Pp. 160, with 279 illustrations. Los Angeles: Kenneth S. Davis, 1938.

This monograph is apparently exactly what the author intended it to be according to his preface, merely a manual of roentgen diagnosis—a manual having been defined as a short compendium and a compendium as an abridgment. For this reason it is obviously incomplete

as a textbook and is intended for students only as an outline to follow in a more complete consideration of the subject. In outline form, certain fundamental concepts are brought out about various conditions which the roentgenologist encounters in routine work. It is much on the same order as other student manuals which various institutions have compiled for this particular purpose.

The author's discussion of the limitations of the roentgen examination is very good as is also his discussion of the commonly misinterpreted roentgen shadows and the variations of the normal. However, when he discusses the abnormal, very little explanation for the various roentgen findings listed is given in terms of gross pathology, particularly in the diseases of bone. These omissions probably were deliberate. Moreover, certain arbitrary classifications and dogmatic statements about debated points might be criticized, but in the main it forms a very good working basis for the average student.

The illustrations are well done, both the drawings and the reproductions of roentgenograms. The set-up of the book is neat and there are but few typographical errors. Its physical design might be smaller for one usually thinks of a manual or short compendium as a pocket edition which can readily be carried about and used as a reference. However, the author's students should be pleased to be able to obtain his lecture notes in this form.

Paul C. Swenson

Radiodiagnostico. Tomo I. Fisica de los rayos X aparatos. By Gonzalo Esguerra Gomez, Profesor en la Facultad de Medicina de la Universidad Nacional. Cloth. Pp. 115, with 80 illustrations. Bogota, Colombia, S. A., 1938.

Radiodiagnostico. Tomo II. Sistema Oseo. By Gonzalo Esguerra Gomez, Profesor en la Facultad de Medicina de la Universidad Nacional. Cloth. Pp. 335, with 400 illustrations. Bogota, Colombia, S. A., 1939.

In Volume I the author follows the usual routine in his consideration of roentgen rays, starting with their nature and their production by the various kinds of apparatus, and finally their application in roentgenology. In Volume II the bones are discussed, both in their normal and pathologic roentgenologic aspects, and included also is a consideration of the teeth and their abnormalities. The information included is condensed to its essentials, yet the coverage of the subject matter seems adequate for teaching the fundamentals of roentgenology. Both books suffer from the mediocrity of the illustrations.

E. T. Leddy

Grundlagen der Röntgendiagnostik und Röntgentherapie. Von Chefarzt Dr. G. Schulte, Knappschafts-Krankenhaus Recklinghausen, und Doz. Dr. med. habil. F. Kuhlmann, Medizinische Universitätsklinik Halle a. S. Paper, price, RM. 7.50; bound, RM. 8.50. Pp. 140, with 148 illustrations. Leipzig: Georg Thieme, 1939.

The authors wrote this book for the medical student whose curriculum includes now lectures on radiology and also for the young practitioner whose needs can be met by a simple introductory text. The physical and technical principles are discussed first followed by a very brief outline of the fundamental diagnostic features in the roentgen examination of bones and joints, lung, heart, aorta, digestive tract, gallbladder, pancreas and genitourinary tract. There is also a condensed introduction to roentgen therapy which because of the limited space available touches only some of the basic principles. The illustrations are good; if used by the group for which the book is intended it will serve its purpose well.

Ernst A. Pohle

Erbegnisse der physikalisch-diätetischen Therapie. Ingemeinschaft mit Prof. Dr. W. Heupke, Oberarzt an der Med. Universitäts-Poliklinik Frankfurt a. M., Hofrat Dr. J. Kowarschik, Primararzt und Vorstand des Institutes für physikalische Heilmethoden im Krankenhaus der Stadt Wien, und Doz. Dr. J. Kühnau, Direktor des Städt, Forsch.-Inst. für Bäderkunde und Rheumaheilanst, Wiesbaden. Herausgegeben von Prof. Dr. H. Lampert, Direktor des Univ.-Inst. für physikalische Therapie, Frankfurt a. M., und des Univ.-Inst. für Quellenforsch und Bäderlehre, Chefarzt am Kreiskrankenhaus Bad Homburg v. d. H. Band I. Paper, price, RM. 25.50; bound, RM. 27. Pp. 410, with 94 illustrations. Dresden und Leipzig: Theodor Steinkopff, 1939.

The publication of this series of monographs, of which the first volume has just appeared, is a symbol of the present day tendency in German medicine: Physico-dietetic and chemo

(drug) therapy are to be placed on equal footing. As the editor points out in his foreword many valuable suggestions have come from non-medical groups called in Germany "nature healers" and it is the intention to publish additional reports of investigations in this field. Because the topics discussed in this first volume are all more or less outside the radiologist's sphere, it may suffice to enumerate the various chapters and their respective authors: Occupational Therapy of Diabetics (G. Katsch, Greifswald), Fever Therapy (H. Lampert), Scientific Principles of the Partial Bath (R. Gruner, Frankfurt on Main), Practice and Theory of Thalassotherapy (C. Häberlin, Wyk a. Föhr), The Limitations of "Artificial" Climate and the "Natural" Climate as a Therapeutic Agent (W. Amelung, Königstein), The Present Status of Electric Short Wave Therapy (J. Kowarschik, Wien), The Influence of the Preparation on the Digestibility of Vegetable Food (W. Heupke, Frankfurt on Main), Diet in Skin Diseases (M. Schubert, Frankfurt on Main), Accessory Food in the Diet of Pregnancy (G. Gaehtgens, Leipzig), Physico-Dietetic Treatment of Hyperthyroidism (W. May, Kreuth), Protamin-Zinc-Insulin (H. Reinwein, Giessen). Bibliographies are appended to each chapter.

Ernst A. Pohle

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

HENDERSON, W. R. The pituitary adenomata; a follow-up study of the surgical results in 338 cases (Dr. Harvey Cushing's series). *Brit. J. Surg.*, April, 1939, *26*, 811–921.

This paper is a report of the early and late surgical results in a series of histologically verified pituitary adenomata operated upon by Dr. Harvey Cushing. The series include 338 verified tumors, 260 of which were chromophobe adenomas, 67 eosinophilic adenomas, and 11 adenocarcinomas.

Whether the tumor is likely to grow downward destroying the hypophyseal fossa or upward through the dura to form a small suprasellar extrusion or a large intracranial extension depends upon several factors. According to the author, these factors are not wholly understood but included among them are the relative strength of the diaphragma sellae and the presence or absence of a strong bony septum in the sphenoidal sinus. Within the hypophyseal fossa, adenomas have no capsule. However, when the adenoma has broken through the dural framework into the cranial chamber, it is delimited by a well defined soft capsule of its own substance which prevents the tumor from becoming adherent to or infiltrating the surrounding structures.

The evolution of the present transfrontal approach for pituitary tumors and the operative mortality are reviewed.

The end-results based upon the patient's condition six months after operation showed that 65 per cent returned to their normal work. In 29 per cent, there was no improvement and in 5 per cent, the symptoms had progressed in less than six months.

In 10 per cent of the cases, homonomous hemianopsia was present which was of two clinical types, depending upon whether the optic tract or the optic radiation was chiefly involved. The author calls attention to the fact that vision may return to an eye which has been blind for as long as three months and when light perception is still present, restoration may be complete following surgery.

In order to determine the beneficial effects of postoperative roentgen therapy, the author compared the results following trans-sphenoidal operation alone with a group of cases in which trans-sphenoidal operation was combined with roentgen therapy. Thirty-two per cent of the patients operated upon revealed evidence of improvement which was increased to 65 per cent when roentgen therapy was added to the trans-sphenoidal procedure. Of the patients who had transfrontal operations alone, 57 per cent remained free from recurrence for five years which was increased to 87 per cent following the addition of roentgen therapy to the transfrontal procedure. The author calls attention to the fact that radium implantation by the trans-sphenoidal route was dangerous because of bone necrosis and eventual meningitis.

About 17 per cent of the adenomata proved to be cystic and they could not be clinically differentiated from the solid tumor. The evidence indicates that the cysts should be treated in the same manner as solid tumors, that is by transfrontal operation plus roentgen therapy.—*P. J. Hodes.*

KUNKEL, PAUL A., and DANDY, WALTER E. Subdural hematoma; diagnosis and treatment. *Arch. Surg.*, Jan., 1939, *38*, 24–53.

This excellent article deals with almost every phase of the subject. Most of the report concerns itself with the authors' series of 48 cases.

The average age was forty-one years although subdural hematomas were found with almost equal frequency in every decade. Whereas trauma seemed to be the immediate cause of the hemorrhage in 66 per cent of the cases, no history of injury could be obtained in 36 per cent of the series. The average duration of illness for the entire group was thirteen weeks. Of the patients on whom a history of trauma had been obtained, a latent interval was present in 43 per cent. The remaining patients' symptoms were dated from the time of the accident.

The principal symptoms were those of intracranial pressure. About 94 per cent complained of headache which was of no value as a localizing sign. Drowsiness, vertigo, diplopia and convulsions were reported. For most of the pa-

tients, the chief objective findings were indicative of intracranial pressure. In only 40 per cent of the cases were the reflex changes of localizing value.

Ventriculography was used as a routine diagnostic procedure. In general, the roentgenographic changes in subdural hematoma resembled those of a dural endothelioma. In every instance, there was displacement of the ventricular system to the contralateral side in the anteroposterior view. With one exception, the anterior horn in cross section was smaller on the affected side. A sharp, straight, ventricular defect on the superior surface of the affected ventricle and a concave indentation on the outer surface of the lateral ventricle were characteristic. The third ventricle was displaced obliquely away from the lesion and the contralateral ventricle was frequently dilated. In the lateral view, without exception the affected ventricle was reduced in size throughout its longitudinal extent.

The pathological findings in subdural hematoma are characteristic. Dark fluid blood which never clots is hermetically sealed in membranes which prevents extension. The outer membrane is thick, vascular, and snugly attached to the dura. The inner membrane is thin and avascular. The volume of blood varied from 40 to 240 cc.

The treatment is surgical. A small craniotomy opening with evacuation of the hematoma is the operation of choice.—*P. J. Hodes.*

Love, J. Grafton, Shelden, C. Hunter, and Kernohan, James W. Tumor of the hypophysial duct (Rathke's cysts). *Arch. Surg.*, July, 1939, *39*, 28–56.

These authors call attention to the fact that hypophysial duct tumors are extremely rare. The present report concerns itself with a series of 11 cases in which operation was performed with no mortality and excellent result. After brief discussions of the embryology, gross and microscopic appearances and pathological changes of the tumor, the authors discuss the symptoms. They call attention to the exact site of origin of the tumor in relation to the dural roof of the sella turcica as determining factors in the development of the character of the clinical symptoms. It is interesting to note that tumors arising from the superior cells produced choked disc and secondary optic nerve atrophy whereas tumors arising from the inferior cell group cause early primary atrophy of the optic nerve. Hydrocephalus was a prominent feature although the signs of increased intracranial pressure generally appeared late in the course of the disease.

The authors call attention to the fact that hypophysial duct tumors occur predominantly in children or in young adults in whom it may remain asymptomatic for many years. Neurological examinations of these patients were essentially negative though symptoms of encroachment upon the frontal lobe were present. The roentgenograms of the head revealed definite erosion of the sella turcica in 10 of the 11 cases reported. In addition, 8 of the 11 patients revealed suprasellar calcification in the roentgenograms.

It is the authors' opinion that medical measures have no place in the treatment of hypophysial duct tumors. They advocate transfrontal surgical approach to the tumor with removal of as much of the growth as is possible following aspiration.

The clinical records of the patients reported are recorded in detail.—*P. J. Hodes.*

Gross, Sidney W., and Ehrlich, William. Frontal puncture for ventriculography. *Arch. Surg.*, July, 1939, *39*, 122–124.

The authors call attention to the following advantages of frontal puncture:

1. Frontal horns vary in position less frequently than posterior horns.
2. Choroid plexus trauma incident to posterior horn puncture is avoided.
3. With the patient lying in the brow down position, the third and fourth ventricles are more completely drained through the anterior approach.
4. Chances for occipital pole visual center trauma are obviated.
5. Multiple punctures to find the ventricle are no longer necessary.—*P. J. Hodes.*

Rowbotham, G. F. The hyperostoses in relation with the meningiomas. *Brit. J. Surg.*, Jan., 1939, *26*, 593–623.

The author concerns himself with the nature of the changes observed in cranial bones overlying meningiomas. In a series of 100 meningiomas, hyperostosis was observed in 23 instances.

The vascularity of meningiomas varies considerably from the markedly vascular angioma-

tous tumors to the relatively avascular psammomas. Their arterial supply springs largely from the dura and the pia. Of interest is the ichness of the circulation within the tumor andrneighboring structures. Communication be tween the dural veins and diploe of the skull are numerous and important, becoming considerably increased and dilated in meningiomas. The diploe may then drain into the scalp causing serious bleeding when the scalp overlying a meningioma is resected at operation.

Clinically, hyperostoses may be divided into three main groups. Patients with obvious and palpable tumors of the skull were included in the first group. The term "iceberg tumor" has been applied to this type because of the extensions beneath the skull. Enostotic growths best seen in tangential and stereoscopic films constitute the second group. Deformities of the orbit associated with unilateral exophthalmos formed the third type.

The hyperostoses may also be grouped according to their pathological features. In general, hyperostoses of the vault lay down bone in trabeculation parallel to the vault with a thin fluffy layer of bone capping the lesion. The whole bony mass is porous. The inner surface is usually spiculated or eroded with the meningioma and hyperostoses intimately dovetailed.

Meningiomas occurring in the base of the skull are usually the en plaque variety which may also produce hyperostoses.

In rare instances, meningiomas may destroy the overlying bone producing an osteoclastic rather than hyperostotic lesion. Usually tangential views of these lesions show bone expansion with a very thin shell of external table remaining.

Circumscribed nodal mounds of bone springing from the inner table of the vault also exist. That these nodal enostoses may merely be an early stage in the diffuse hyperostoses is suggested.

Attempts to establish a relationship between tumor type and the character of the bone changes overlying the meningioma proved nothing of significance. The evidence indicated that new bone formation in these tumors was due to reactive changes in the skull and was not an integral part of the tumor.

The route of bone invasion seems definitely along blood vessels.—*P. J. Hodes.*

Anderson, Bert G. Epulis. *Arch. Surg.*, June, 1939, *38*, 1030–1035.

The author defines the term "epulis" as a benign epithelium-covered connective tissue tumor found immediately around the teeth and having its origin in the pericementum or periosteum of the marginal alveolar process. It may be classified according to the predominant type of tissue found histologically. Thus tumors in which connective tissue predominates have been termed fibromatous epulis. Tumors with marked vascularity have been called angiomatous epulis. Benign giant cell epulis has been applied to tumors in which giant cells predominate. Only characteristic of the giant cell epulis was the appearance of giant cells in the tumor.

The author excises the tumors surgically taking care to curette the region of the attachment. Teeth displaced by the tumor mass were removed. There were no recurrences.—*P. J. Hodes.*

NECK AND CHEST

Wolferth, Charles C., and Margolies, Alexander. Movements of roentgen-opaque deposits in heart valve areas. II. The excursion of the apex and base of the left ventricle compared with that of the left border. *Am. J. M. Sc.*, Feb., 1939, *197*, 197–201.

The authors have previously described 3 cases of endocardial calcifications which were studied roentgen kymographically.

They noted that during systole the calcifications moved toward the apex but they were not able to properly visualize the apex (above the dome of the diaphragm) to prove that the apex moves inward and upward toward the base (as described by Dietlen, in 1910). Nevertheless they regarded the evidence as adequate to believe that the important feature of left ventricular contraction is shortening of the long axis, and not only does the apex move toward the base, but the base moves toward the apex.

The present report concerns 2 additional cases. One did not show any enlargement of the cardiac measurements, which feature indicated that the calcium did not involve the leaflets to any great extent and was probably in the neighborhood of their attachments. Roentgen kymography was performed with the patient in a special recumbent position providing for visualization of the base and the apex through the horizontal slits; the focal spot was aligned

midway between the two and the timing was controlled by a simultaneously recording electrocardiogram.

It was found that very early in systole, the calcium deposit begins to move abruptly toward the apex (as previously reported), and at the same time, movement of the apex toward the base begins. When these excursions are wide the result is that the left ventricular border is actually moving outward instead of inward. Recovery of the original position of the ventricular walls begins about the middle of systole and continues during the latter half of it.

A sixth case was studied where calcifications in the right coronary artery (lying in the auriculoventricular groove) could be observed. During systole, the artery and the apex were seen to move toward each other, indicating that the auriculoventricular groove was being pulled toward the apex.

These studies seem to indicate that roentgen kymography of the left ventricular border may fail to reflect the most important part of movement during contraction.

Physiologically, these studies as well as others based on recorded phlebograms suggest that the floor of the right auricle is pulled downward during ventricular systole—thereby increasing the suction of blood from the larger veins. The elongation of the ventricles during diastole, in the same way, aids in ventricular filling.—*A. A. de Lorimier.*

Garvin, Curtis F., and Siegel, Mortimer L. Cor pulmonale due to obstruction of the pulmonary artery by syphilitic aortic aneurysms. *Am. J. M. Sc.*, Nov., 1939, *198*, 679–685.

Syphilitic involvement of the aorta may produce aneurysms without cardiac failure but when the aneurysms involve the aortic root with dilatation of the aortic ring, myocardial insufficiency frequently results. Less commonly myocardial insufficiency may result because of compression of the pulmonary artery by aneurysmal out-pocketings from the aorta. In some such cases, the aneurysm may rupture into the pulmonary artery. Without rupture, there may be produced a stenosis of the pulmonary artery and thereby a marked dilatation of it, a so-called "cor pulmonale," and finally myocardial deficiency. Three cases of this are reported. The aneurysms were located in the ascending arch of the aorta, involving either the sinuses of Valsalva or the region just above the commissures. In one case the size of the aneurysm was quite small, only about 6 cm. in greatest dimension, but the location, anterior and to the left, was effective. All cases showed hypertrophy and dilatation of the right ventricle (in one, there developed a tricuspid insufficiency). Clinically, cyanosis was noted and a systolic murmur was heard but this was not diagnostic. Electrocardiographic studies revealed a right axis deviation.—*A. A. de Lorimier.*

Armstrong, Eugene L., Coggin, Charles B., and Hendrickson, Herman S. Spontaneous arteriovenous aneurysms of the thorax. *Arch. Int. Med.*, Feb., 1939, *63*, 298–317.

Spontaneous arteriovenous aneurysm was reported by Beevor in 1832. Since then, similar reports have followed until in 1925, 98 of such cases were recorded. The authors have analyzed 81 cases (2 of their own), 24 of which were not included in previous summaries. Only 2 such cases were found among 19,000 autopsies at the Los Angeles County Hospital, of which 192 showed aneurysms of the aorta. Where the records provided the necessary information, the following analyses were obtained:

Age and Sex: Greatest age incidence was between forty and sixty; 90 per cent males.

Etiologic Factors: Positive evidence of syphilis in 87 per cent, (authors believe that previous statistics cite syphilis in too low a percentage, due to fact that specific tests have been available only since 1906).

Exciting Cause of Perforation: Physical and emotional strain seemed important.

Symptoms and Physical Signs: Of 80 cases in which these features were cited there were noted: sudden onset in 62 per cent; cyanosis in 80; swelling in 79; suddenness of onset in 50; dyspnea in 35; unconsciousness in 16; pain in 15; orthopnea in 9; tightness of neck and head in 8 and dysphagia in 6. Cardiac murmurs were mentioned in 77 (typically continuous murmur augmented in intensity during the ventricular systole and diastole and in both with a great degree of purring tremor).

Length of Survival after Perforation: Immediate death, 3; less than twelve hours, 4; less than twenty-four hours, 5; one to two days, 2; two to three days, 2; three to seven days, 8; up to one week, 24; one week to one month, 30;

one to two months, 14; over two months, 13 (total of 81).

Position of Perforation: Of the 81 cases, there were double perforations in 7; triple in 3. In 41 the perforation was mentioned as above the azygos; in 4, at the termination of the azygos; in 18, between the azygos and right auricle; in 2, at the entrance of the auricle; in 3, through the wall of the right auricle. When the perforation was located above the azygos, the swelling and cyanosis were more or less limited to the head, neck or upper extremities; when below the azygos, there were swellings of the thorax and lower extremities.

The average diameter of the aneurysm was 8 cm. The origin was in the ascending aorta.

The authors emphasize the value of the "Hall and Rowlands sign"— an increase in the systolic blood pressure in the leg, as compared with the arm, with a lowering of the diastolic pressures. They also emphasize the importance of pulsation of superficial veins.—*A. A. de Lorimier.*

McGUIRE, JOHNSON, and BEAN, WILLIAM B. Spontaneous interstitial emphysema of the lungs. *Am. J. M. Sc.*, April, 1939, *197*, 502–509.

Spontaneous interstitial emphysema was described in 1937 by Hamman and since then, this condition has been described as "Hamman's disease." Mediastinal emphysema had been described by Laennec and later it has been recognized with such conditions as pertussis, croup, severe crying, the labor of child bearing, bronchial asthma, straining at stool, the induction of artificial pneumothorax and pneumonia. Most analyses have been based upon such clinical evidence as sudden onset of pain in the chest with bubbling, crunching sounds heard over the heart, the decrease or loss of cardiac dullness, the finding of subcutaneous emphysema, etc.

Interstitial emphysema is caused by rupture of alveoli or bronchioles and thereby the escape of air into the interstitial tissues. It may dissect along interstitial bands toward the hilum and even enter the mediastinum; it may simply pass outward to the pleura and develop blebs—which might rupture and produce an ordinary pneumothorax—or both directions may be followed.

Two cases are reported. In both instances, the condition was considered because of clinical evidence and the diagnosis was substantiated by roentgenography. The importance of both the posteroanterior and lateral projections is emphasized. In one instance, the precipitating factor seemed to be the exercise of basket ball; in the other, the exertion of obstetrical labor.

Treatment should be conservative and palliative, making use of 95 per cent oxygen in extreme cases.—*A. A. de Lorimier.*

ESCUDERO, LUCILO, and ADAMS, W. E. Spontaneous pneumothorax associated with massive atelectasis. *Arch. Int. Med.*, Jan., 1939, *63*, 29–38.

Atelectasis of the lung is a well known condition as is also spontaneous pneumothorax but the combination of these two conditions is not so well known.

The author reports one such case and refers to others reported in the literature. He also reports similar findings in 9 experimental animals —8 dogs and 1 goat. In these, bronchial stenosis was produced by the application to the bronchial mucosa of 35 per cent silver nitrate; atelectasis resulted within about two weeks. In one dog it was found that a pneumothorax also developed. Therefore in others, air was actually injected into the side opposite to that where the atelectasis had occurred. They were able to demonstrate movement of the air from the injected pleural cavity into the atelectatic side. This was accomplished probably mainly by suction of the air through the mediastinum because of the excessive negative pressure of the atelectatic side.

It therefore seems plausible that with the production of massive atelectasis the loss of volume due to the collapse of the lung is compensated for by hyperinflation of other portions, possibly with resultant overstretching of the pleura and ultimate pneumothorax. In humans this combination is relatively rare for two reasons: the extent of atelectasis is usually limited to one lobe or portion of one lobe and it seldom involves a complete lung; moreover the mediastinal tissues of a human are much thicker than those of the dog.—*A. A. de Lorimier.*

FRANKLIN, R. MAXWELL. Bronchographic study of apparently healed lung abscesses. *Am. J. M. Sc.*, July, 1939, *198*, 95–98.

The incidence of recurrence of lung abscesses indicates that healings are oftentimes incomplete. Residua can be studied bronchographically; cavities or bronchiectasis may be found. With such recurrences trouble may be expected

and for this reason six months convalescence and routine bronchographic studies have been recommended, following clinical improvement. Six case studies are presented where bronchograms revealed abnormalities even though routine roentgenographic studies appeared normal. The authors consider bronchiectasis a relatively hopeless condition, the cure probably based upon the recession of symptoms rather than disappearance of the bronchiectasis. The findings of such are therefore considered potentially dangerous.—*A. A. de Lorimier.*

Pagel, W., and Simmonds, F. A. H. The healing of cavities. *Am. J. M. Sc.*, March, 1939, *197*, 281–286.

The same physiological and pathological processes appear to be at work whether healing of cavities be accomplished spontaneously or whether active collapse be instituted. Laennec, Latham, and others, have recorded observations that cavities might heal by becoming lined with a natural membrane, or the diseased area might be replaced by fibrous scar tissue.

The authors discuss this general subject with analysis of 4 cases. They found a third method of obliteration, namely by the deposition of calcium salts. Obliteration of the cavity and the nearby bronchial lumen may result by kinking of the bronchus, with collapse therapy, edema of the walls, the accumulation of tuberculous granulation tissue, fibrous stenosis and by obstruction by a plug of caseous material.—*A. A. de Lorimier.*

Hochberg, Lew A., and Lederer, Max. Early manifestations of primary carcinoma of the lung. *Arch. Int. Med.*, Jan., 1939, *63*, 80–99.

The authors have analyzed case records of patients admitted to the Jewish Hospital of Brooklyn between 1917 and 1936, inclusive. Of these, 170 were found to have carcinoma of the lung, 47 of whom were free of thoracic symptoms until about one month before admission, 13 of whom gave no history referable to the thorax. This analysis concerns mainly these latter 60. Twenty-five of these cases were correctly diagnosed from history, clinical course and roentgen studies; 22, by bronchoscopic studies with biopsy or puncture of the lung or by finding malignant cells in the sputum of pleural fluid; in 13, the diagnosis was confirmed by necropsy.

The following features are emphasized:

Age and Sex: Rarely encountered under twenty (Beardsley reported a case in a child of sixteen months); few cases, between twenty and thirty; most cases, over forty (about 72 per cent). Between 70 to 80 per cent of cases reported have been males.

Signs and Symptoms: Variable, may be no symptoms associated with thorax. When thoracic symptoms were present they included: cough (91.5 per cent); pain in the chest (57.7 per cent); expectoration (44.7 per cent); dyspnea (42.5 per cent); hemoptysis (40.4 per cent); asthmatic wheezing (34 per cent). In addition, there was found: loss of weight (42.5 per cent); malaise (29.8 per cent); epigastric distress (26.8 per cent); anorexia (26.8 per cent); fever above 100.5°F (19.1 per cent); night sweats (19.1 per cent); hoarseness (14.8 per cent); pain in the neck, shoulder, etc. (14.8 per cent); pain in the sacroiliac region (12.7 per cent) and nausea and vomiting (8.5 per cent). Where there were no thoracic symptoms the most frequent complaints were as follows: epigastric distress (53.9 per cent); anorexia (53.9 per cent); nausea and vomiting (46.2 per cent); malaise (38.5 per cent); loss of weight (30.8 per cent) constipation (30.8 per cent) and aphasia (15.4 per cent). Physical findings varied markedly: possibly percussion dullness; tubular or asthmatoid breathing; perhaps simply depressed breath sounds.

Roentgenological examinations revealed minimal changes in the beginning (or perhaps no evidence at all); perhaps unilateral opacity, either crescentic with its convexity toward the lung, or triangular, with its base toward the side of the lesion; perhaps regional pneumonitis; perhaps localized hydrothorax; perhaps filling defects as visualized by bronchography.

Bronchoscopic examination was trustworthy in about 75 per cent of cases (Jackson and Konzelmann).

Eleven cases are reported in detail to emphasize these aspects.—*A. A. de Lorimier.*

Goodman, B. A. Fibrocystic disease of the breast. *Arch. Surg.*, May, 1939, *38*, 917–933.

The author suggests the term "fibrocystic disease of the breast" to replace the diverse terms applied to a group of conditions referred to as cystic disease, Schimmelbusch's disease, mazoplasia and so forth. The condition is essentially a functional disorder of the non-lactating breast.

Clinically, the condition is characterized by fullness and enlargement of the breast often

associated with sensations of tingling or pain. Occasionally, the pain may radiate into the chest or arm. Bleeding or discharge from the nipple may accompany these symptoms. Not infrequently the condition is asymptomatic.

Palpation may reveal a normal breast consistency or a diffuse nodularity referred to as "shotty breast." Moderately firm, irregular, freely movable masses varying in size from 1 to 10 cm. are frequently encountered.

The cause is uncertain. Lack of natural drainage of the products of secretion in the breast may be a factor. Only a small proportion of women with fibrocystic disease have a history of normal lactation. Of importance is the fact that the condition is frequently associated with pathologic conditions of the pelvis and nervous instability. Most physicians agree that aberrant stimulation of the luteal hormone progestin and the associated hormones estrogen and prolactin are of paramount importance.

The author calls attention to the relationship between fibrocystic breast changes and malignancy.

In many cases, treatment with potent estrogenic substances is efficacious.—*P. J. Hodes.*

ABDOMEN

Lipshutz, Benjamin, and Chodoff, Richard J. Diagnosis of ruptured abdominal aortic aneurysm. *Arch. Surg.*, August, 1939, *39*, 171–181.

Several general clinical features are important in the diagnosis of ruptured abdominal aortic aneurysm. The pain of rupture is sudden, violent, usually abdominal but occasionally lumbar. Shock is severe and persistent. In contrast to the severe abdominal symptoms, there is little tenderness or rigidity. A localized mass is often felt. The presence of pulsation or a bruit is classical. Leukocytosis is common. An increase in urine diastase may be important.

The survey abdominal roentgenogram often reveals obliteration of the psoas shadow. Secondary roentgenographic signs of aneurysm, calcification and vertebral erosion are extremely significant.—*P. J. Hodes.*

Lowry, Tom, and Moorman, Lewis J. Accessory stomach in the right thorax. *Am. Rev. Tuberc.*, July, 1938, *38*, 27–31.

The author reports the operative and postmortem findings in an infant with an accessory intrathoracic stomach. Roentgen studies of the chest revealed extreme atelectasis in the right hemithorax. An air and fluid level within the affected chest suggested a cystic tumor. Of unusual interest was the normal appearance of the diaphragm in spite of the accessory stomach in the right chest. The air bubble in the normal stomach was in its usual position below the dome of the left diaphragm. Fluid aspirated from the cystic lesion revealed the characteristic properties of normal gastric juice.—*P. J. Hodes.*

Dulin, J. W., and Peterson, F. R. Intestinal obstruction due to gallstones. *Arch. Surg.*, Feb., 1939, *38*, 351–357.

According to these authors, intestinal obstruction due to gallstones occurs often enough to merit consideration in the diagnosis of acute abdominal conditions. This is particularly true when the patient has had previous gallstone attacks. A large gallstone may enter the gastrointestinal tract through the common duct or through a fistula between the gallbladder and the bowel. The latter route is more common and is the result of inflammatory adherence of the gallbladder to an adjacent viscus. Pressure of the gallstone causes necrosis and erosion of the gallbladder and intestinal walls.

Early examination reveals nothing but tenderness in the upper abdomen. Abdominal distention is rarely noted early. The obstruction may be partial or complete. Survey abdominal films occasionally visualize the stone.—*P. J. Hodes.*

Abbott, W. Osler. Intubation of the human small intestine. XII. The treatment of intestinal obstruction and a procedure for identifying the lesion. *Arch. Int. Med.*, March, 1939, *63*, 453–468.

Beneficial effects of intestinal intubation include: emptying the intestine and restoring peristalsis; supplying promptly the data needed in the adjustment of the fluid and electrolyte balances of the body; relieving the obstruction itself; identifying the location and nature of the lesion; simplifying the technique of any surgical procedure; protecting the suture line after operation and converting an emergency into an elective surgical procedure.

The author makes use of a tube and balloon arrangement which can be inserted intranasally and fed into the stomach. The tube may have a double channel or a tube within a tube may be used whereby aspiration can be accomplished and yet the balloon might be inflated. This

balloon is fixed to the end of the tubing and after passage through the pylorus it is partially inflated thereby providing for peristaltic movement of it and the tubing. This manipulation can be controlled so that the movements of the balloon and the tubing can be accelerated by proper distention of the balloon or so that peristalsis can actually be inhibited because of over-distention.

Case examples are cited to describe the attributes of this apparatus in the various ways described above.—*A. A. de Lorimier.*

GENITOURINARY SYSTEM

Higgins, Charles C. Squamous cell carcinoma of the renal pelvis. *Arch. Surg.*, Feb., 1939, *38*, 224–244.

Squamous cell carcinomas of the renal pelvis occur less frequently than other neoplasms of the kidney. The evidence suggests they are the result of leukoplakia of the renal pelvis. The majority of squamous cell lesions of the renal pelvis occur in the fifth decade of life. They are found more frequently in men than in women.

No definite symptoms are pathognomonic. Hematuria, pyuria, loin pain and weight loss constitute the more common symptoms.

The diagnosis is frequently difficult. Renal tuberculosis, calculi, and parenchymal tumors may mimic the findings of primary squamous cell renal tumors. Pyelography is the most important means of establishing a diagnosis as it helps considerably in the differential diagnosis of the latter condition.

Leukoplakia and renal calculi are frequently associated with these tumors. Hydronephrosis or pyonephritis due to coexisting calculi are not uncommon.

Two types of lesions predominate. In the first type, the tumor invades the renal parenchyma early and eventually replaces it. In the second type, the lesion is confined chiefly to the renal pelvis. Metastases occur early and are widespread.

The treatment is surgical, irradiation being of little value. The prognosis is very poor, the average duration of life being seven to eight months.—*P. J. Hodes.*

SKELETAL SYSTEM

Taylor, Fletcher B., Michael, Paul, and Barnard, Leonard. Abnormalities of calcium metabolism. *Arch. Int. Med.*, Feb., 1939, *63*, 226–248.

The authors call attention to various clinical entities which are based upon abnormalities of calcium metabolism:

Case 1. "Calcinosis universalis"—a male, aged twenty, of slight build who suddenly developed multiple muscle and tendon achings and, following transient improvement, about two years later, repeated the bouts of achings. He was found to have extensive calcifications in muscles and tendons throughout his body. Studies as to blood calcium and inorganic phosphorus were normal. The carbon dioxide combining power of the blood plasma was 61.5 volumes per cent. The pH of the blood was 7.5. The changes have been explained by Klotz that a poor blood supply and lessened viability of the cells result in the formation of a succession of alkaline soaps, with final deposition of calcium soap. These changes are simulated in scleroderma, in myositis fibrosa and dermatomyositis. Thyroid extract, local hyperemia, calcium biphosphate and ketogenic diets have been tried but no type of treatment seems to be reliably beneficial.

Case 2. Renal rickets. Two examples of this condition are described; one, a girl of six years; the other, an eleven year old boy. The condition is considered to be essentially a nephritis where there results a retention of phosphates and therefore an upset in the calcium-phosphorus balance with reduction in the circulating calcium. Because of this, plus the acidosis which is usually concurrent, the calcium and phosphorus are not properly utilized by the skeleton. Both cases had high blood pressures (one, a systolic of 200 with a diastolic of 150). Roentgenograms showed deossifications. A blood calcium of 8.8 mg. and a phosphorus content of 5 mg. were recorded in one of these cases. Parsons is quoted as advising against the use of ultraviolet in these cases—because of increasing the absorption of phosphate; the authors therefore suggest that vitamin D might be interdicted.

Case 3. Fragilitas ossium ("hereditary hypoplasia of the mesenchyme"). A girl of seven years who had had a number of fractures; retarded mental and physical developments were noted. Her mother had deformities of the spine and both she and a half-sister had blue scleras. Roentgenography revealed rarefied bones but reasonable healings at the sites of the fractures. Her blood calcium was 10 mg. but the inorganic phosphorus was only 2.1 mg. per 100 cc. Calcium, phosphorus and viosterol were administered and after three months, the patient had

gained 10 pounds and was more energetic. Her blood inorganic phosphorus had climbed to 4.5 mg. The consideration of phosphorus need in this condition is emphasized.

Case 5. Parathyroid adenoma. A woman, aged forty-five, who was admitted because of a fracture of the femur. While attempting to pull herself around in the bed, her thorax collapsed and she died of pneumonia. Nine ribs were fractured by the effort. Roentgenography revealed generalized deossifications. Adenomas of both the thyroid and parathyroid were found at postmortem. There was also a hyperplasia of the adrenal cortex. The pituitary was not studied. The ribs could be cut with ordinary shears. Since diffuse demineralization, rather than cystic changes, was found, the authors suggest "combined effects of the parathyroid adenoma and thyrotoxicosis."

Case 6. Diffuse bony metastases from a renal cell carcinoma. A physician, aged sixty, who was studied because of pain in the lower portion of the back, lassitude, mental confusion, anorexia and palpitation. Diffuse rarefaction of the skeleton was found roentgenographically. The blood calcium was 16 mg. per 100 cc.; the inorganic phosphorus, 3.2. During five days of study there was found to be a calcium deficit of 3,474.8 mg. No abnormal masses could be palpated in the neck. Aberrant parathyroid tumor was suspected and he was referred for surgical exploration (twelve years before admission, he had had surgical removal of the left kidney for renal cell carcinoma). The patient died eleven days after the exploration and autopsy revealed a recurrence of the carcinoma of the renal tumor at the operative site and metastatic carcinoma was established in the regions of skeletal rarefaction.

Case 7. Senile osteomalacia. A sixty-five year old charwoman who fell while working and had a severe pain in her back. She was found to have a compression fracture of the first lumbar vertebra. All vertebrae showed marked deossification. After months of orthopedic care, she was allowed to get around, slowly, but she developed compressions of other vertebrae. She was found to have a negative calcium balance—losing over 7 gm. more calcium that she received, in ten days. Blood studies showed normal calcium and inorganic phosphorus values. She was given calcium and phosphorus (by way of milk and eggs) and viosterol and lactose (to provide for assimilation of the calcium and phosphorus from a fermentative intestinal flora). Roentgen irradiation was applied to the parathyroid regions. Later studies revealed a positive calcium balance of 0.5 gm. in twelve days. She was able to get up and continue with her work. Comment is made as to the fact that "small doses of vitamin D cause poor calcification on bone; larger doses, hypercalcification, and still larger doses, decalcification" "a physician of this community died with polyuria, weakness and anorexia, after taking 2,500,000 U.S.P. units daily for seventeen days."

Case 8. Tetany in an adult. A nervous emaciated woman weighing 83 pounds had been under observation and treatment because of a diarrhea. Five months later, medical aid was sought because of tonic contractions and confinement to bed. Typical tetanic contractions, were noted. Parathyroid extract was administered intramuscularly and calcium chloride was given intravenously with rapid loss of the discomfort. The calcium content of the blood was found to be 5.3 mg. per 100 cc. The diarrhea was again treated; calcium, viosterol, ultraviolet, hydrochloric acid were administered. After ten days in the hospital the blood calcium had risen to 10 mg. per 100 cc. Her weight increased to 105 pounds and though observed at intervals for over six years, there was no recurrence of the tetany. This was believed to be a case of faulty absorption of calcium, probably due to a gastric anacidity.

Case 9. A male, aged fifty-two, who had noted pain and discomfort in his knee and leg on walking, about two years previous to admission; bowing of the leg, about eighteen months previously (with the production of a limp); some soreness even when lying in bed. Roentgenograms showed rarefaction, deformity and density. The highest blood calcium value was 11.3 mg. per 100 cc.; protein, 3.3; phosphatase, 65. Treatment consisted of thermotherapy plus calcium. The authors state that an abortive form of osteitis fibrosa cystica may be confused with Paget's disease. The high phosphatase is believed to liberate inorganic phosphate from phosphoric esters, making inorganic phosphorus available for bone formation.—*A. A. de Lorimier.*

COLEMAN, MARK. Osteitis fibrosa disseminata. *Brit. J. Surg.*, April, 1939, *26*, 705–713.

The author reports complete findings of a patient with osteitis fibrosa disseminata in whom there was no evidence of parathyroid hyperactivity. The blood calcium was normal

and, at the postmortem examination, the parathyroids were normal.

The history in a male child, aged thirteen, was one of repeated fractures due to multiple cystic lesions throughout all of the bones. At operation, one of the cysts was explored and histologically considered fibrocystic disease. The patient died of hermorrhagic pancreatitis and the complete autopsy report is recorded.

The author believes that this case should be grouped with the cases described by Albright as characterized by multiple bone cysts, areas of pigmentation and precocious puberty in females but apparently not in males. The author calls attention to the fact that the syndrome is distinct from hyperparathyroidism in which the biochemical findings of disturbed calcium metabolism are characteristic.—*P. J. Hodes.*

Wright, Louis T., and Logan, Myra. Osseous changes associated with lymphogranuloma venereum. *Arch. Surg.*, 1939, *39*, 108–121.

Occasionally, this disease may be associated with joint pain, hydrarthrosis and pyarthrosis. The authors report 2 proved cases of bone necrosis associated with lymphogranuloma venereum. Both patients revealed roentgen evidence of pubic bone destruction which was subsequently confirmed at operation.—*P. J. Hodes.*

Bennett, George E., and Cobey, Milton C. Hemangioma of joints. *Arch. Surg.*, March, 1939, *38*, 487–500.

The authors report 5 patients with this rare condition and review the literature.

The signs and symptoms are striking. As a rule, intermittent pain and swelling have been present since early life. Slight limitation of motion and absence of pain on motion occur characteristically. A reduction in size of the soft tissue swelling with elevation of the part is typical. Roentgenograms reveal soft tissue swelling with capsular thickening and occasional bone erosion. Aspiration of blood from the patient is an important diagnostic sign as is the presence of other hemangiomas on the body.

The differential diagnosis is important and often difficult. Tuberculosis, tumors, joint mice, lues and torn cartilage must be excluded.

The earlier the treatment is instituted, the more satisfactory the result. The type of treatment is a matter of choice and is dependent upon whether the lesions are diffuse, pedunculated or encapsulated. Small hemangiomas or pedunculated lesions can be easily handled surgically. Larger lesions are best handled by radiation therapy.—*P. J. Hodes.*

Smith, E. J. Radley. Detachment of the medial epicondyle of the humerus with displacement into the elbow-joint. *Brit. J. Surg.*, April, 1939, *26*, 785–790.

There is evidence that in certain individuals, this condition is due to dislocation of the elbow which permits the detached medial epicondyle to lodge inside the joint. In many cases, however, no evidence of dislocation has been demonstrated. In the latter group of cases, it appears that an abduction strain on the joint as a result of which the medial epicondyle is evulsed and the inner side of the joint therefore allowed to open, might account for the injury. The epicondyle which is attached to the ulna by the internal lateral ligament could be drawn downwards, therefore, until it is opposite the elbow joint which is open at the height of abduction, allowing the epicondyle to drop into the inner compartment of the elbow joint.

The cases have all occurred in adolescence, with males predominating. The roentgenographic appearance is characteristic. There is widening of the joint space on the inner side between the trochlea and ulna which may be observed by comparing with the normal side. The presence of a bony body, either hemispherical or crescentic in the joint on the inner side and the loss of the medial epicondylar epiphysis from its normal position makes the diagnosis. A coexisting ulnar nerve palsy is very common. The treatment, in the majority of cases, has been by an open operation though occasionally manipulative reductions have been successful. The end-results are good.—*P. J. Hodes.*

Horwitz, M. Thomas. Lesions of the supraspinatus tendon and associated structures; investigation of comparable lesions in the hip joint. *Arch. Surg.*, June, 1939, *38*, 990–1003.

The author examined 150 shoulder joints postmortem. Thickening of the walls of the bursa, villous formation and partial or complete obliteration of the bursal cavity were not unusual. Complete defects, tears in the supraspinatus tendon were observed in 10 shoulder joints. In almost 50 per cent, the long bicipital tendon was constricted. Fraying, thinning, flattening and tearing of the bicipital tendon also occurred frequently. Proliferative bone changes

involving especially the greater and lesser tubercles were observed.

From this autopsy evidence, the author concludes that the symptom-complex of supraspinatus tendon rupture represents the effect of trauma, often minimal, on tissues which are the site of degenerative lesions incidental to advancing age, defective circulation and excessive use.—*P. J. Hodes.*

GILMOUR, JOHN. Adolescent deformities of the acetabulum; an investigation into the nature of protrusio acetabuli. *Brit. J. Surg.*, April, 1939, *26*, 670–699.

The author differentiates between primary and secondary protrusions. Primary protrusions are related to the development of the bony pelvis. They are commonly bilateral and predominate in females. They show a marked tendency to osteo-arthritis. Secondary protrusions are due to destructive diseases of the hip or trauma damaging the floor of the acetabulum. They are usually unilateral.

These conditions should be differentiated from deep acetabulum which is a minor grade of the primary deformity.

In the early stages, the condition is painless. Limitation of motion may be the only finding and is a function of the depth of the acetabular deformity. A forward tilt of the pelvis and hyperlordosis accompany deep protrusions. Later, progressive stiffness and pain indicative of arthritis, unilateral, or bilateral may appear with secondary degenerative changes manifested in the sacroiliacs. Aseptic bony ankylosis is a rare complication.

It is suggested that the primary disease is due to premature acceleration of primary epiphyseal ossification with the formation of young vascular bone which does not resist stress adequately.

Treatment in cases of protrusions not associated with joint complications may be required for marked limitation of motion and secondary postural deformities. Most patients are treated for osteo-arthritic changes, however, by acetabuloplasty.—*P. J. Hodes.*

GREENE, JESSE J., and SMITH, DAVID H. Fractures of the pelvis. *Arch. Surg.*, May, 1939, *38*, 830–852.

The authors review their experiences with 79 cases.

The majority of pelvic fractures occurred in males. The most common causes of such fractures were automobile injuries and fall from a height.

The average period of hospitalization for patients with uncomplicated fracture of the pelvis was twenty-one days. In the presence of associated injuries, the hospitalization period was forty-eight days. The point is made that the associated injuries are frequently more serious than the pelvic damage. Such fractures being commonly accompanied by injury elsewhere, one must take every precaution not to overlook visceral and neural damage. The importance of hematuria following an accident and its frequent relation to genitourinary trauma is stressed. Neuralgia, sensory changes and weakness in the muscles of the calf and toes associated with pelvic fractures are serious, usually signifying injury to the lumbosacral cord, sacral plexus, or the obdurator nerve

The treatment for uncomplicated pelvic fractures is simple. Little more than strapping or rest in bed is required. Of the 79 patients reported, 14 died.—*P. J. Hodes.*

BLOOD AND LYMPH SYSTEM

GRAY, J. H. The relation of lymphatic vessels to the spread of cancer. *Brit. J. Surg.*, Jan., 1939, *26*, 462–495.

Using thorotrast as a contrast medium, the author studied the lymphatics in a wide range of conditions. The first portion of this report concerns itself with the normal, the second half with the lymphatics associated with malignancy.

Normally there exists a plexus of communicating vessels in the superficial part of the dermis which communicates with another plexus in the deeper portions of the dermis. These are joined by oblique or vertical vessels possessing valves. The lymphatics of the subcutaneous tissue act chiefly as draining trunks for the superficial vessels. The deep fascia is practically devoid of lymphatic vessels. Thus there exists a relatively clear separation of the superficial lymphatics from the internal lymphatics. This separation is the basis for the Kondoleon operation for the relief of lymphedema.

The findings differed considerably in skin overlying malignancies. The ordinary effects of

cancer upon the local lymphatics were purely indifferent mechanical effects leading to compression and disappearance of the lymphatics within the interior of the cancer.

From his study of the lymphatics in malignancy, the author concluded that the spread to lymph glands was generally embolic. Cancer cells did not seem to remain for any length of time within the lumen of lymphatic vessels. This suggested that the spread of cancer by duct extension along lymphatics rarely occurred.—*P. J. Hodes.*

Desjardins, Arthur U. Retroperitoneal lymph nodes; their importance in cases of malignant tumors. *Arch. Surg.*, April, 1939, *38*, 714–754.

According to the author, malignant involvement of retroperitoneal nodes is more serious than similar invasion of nodes elsewhere in the body. In order to stress this fact, the author reviews the anatomy of the lymphatics in the abdomen and their relationship to surrounding nerves, blood vessels and viscera. This anatomical survey is brief, fairly complete and practical.

The manner in which carcinomas and sarcomas invade the retroperitoneal nodes and the symptoms produced by such metastases are discussed fully. In addition, the relation between such nodal involvement and the lymphoblastomatous diseases is also recorded.

The symptoms referable to retroperitoneal node malignancy are, with few exceptions, essentially the same regardless of the histology of the tumor. Backache with or without roentgen evidence of vertebral involvement is common. Abdominal pain may be irregular and of increasing severity or regular and simulate peptic ulcer. As the disease progresses, such pain becomes constant and severe.

Gaseous distention with bloating and belching after meals occurs frequently and may be due to nodal pressure upon the gastrointestinal tract. Meteorism may also be present in such instances.

Palpation reveals characteristic abdominal changes. A sensation of abnormal resistance to palpation, tenderness and a peculiar nodular feel deep in the abdomen are easily recognized in well developed cases. In addition, patients with lymphoblastomatous involvement may run a troublesome febrile course.—*P. J. Hodes.*

ROENTGEN AND RADIUM THERAPY

Erdélyi, Josef, and Irsik, Josef. Ergebnisse der Röntgenbehandlung der Hyperthyreose. (Results obtained from the roentgen treatment of hyperthyreosis.) *Strahlentherapie*, 1939, *64*, 392–407.

Even though the roentgen treatment of hyperthyreosis has been the subject of discussion for decades, no definite conclusions have been reached. This method of treatment is highly endorsed by some and condemned by others. The purpose of roentgen therapy is to decrease the accentuated function of the thyroid gland. Under the influence of the roentgen rays the cellular activity of the thyroid gland decreases. This result may be achieved with a roentgen-ray dose which does not lead to histologically demonstrable changes in the thyroid gland. The hyperactive thyroid gland is more sensitive to roentgen rays than the thyroid gland of normal activity. The decreased activity of the thyroid gland is followed by a decrease of symptoms resulting from the hyperfunctioning thyroid.

Between 1930 and 1937, Erdélyi and Irsik treated 152 cases of hyperthyreosis roentgenologically. In 100 cases the results obtained could be followed up. In these the following data were obtained: 38 per cent were cured, 37 per cent improved and 25 per cent remained unchanged. In the group of cured cases only those were included who were able to return to work, who presented a basal metabolic rate less than plus 10 and who showed a pulse rate not over 80 per minute. In 94 per cent of these patients the temperature elevations disappeared and in 82 per cent the night sweats disappeared. The circumference of the neck returned to normal in 86 per cent; in 79.2 per cent the exophthalmus disappeared and in 80 per cent the tremor disappeared.

In the group of improved cases only those were included in which the basal metabolic rate definitely decreased, the body weight increased, the general condition improved and the subjective symptoms decreased.

Most of the patients treated were women. The percentage of cures and improvements was smaller in men.

Irradiation did not have the same effect on the different types of hyperthyreosis. In general better results were obtained in Basedow's dis-

ease than in cases of hyperthyreosis. Especially good results were obtained in the Basedow patients under twenty-five years of age. In this group of cases 53.8 per cent were cured while in the Basedow patients above twenty-five years of age only 44 per cent were cured. Good results were obtained also in cases of climacteric hyperthyreosis. Of the 34 cases of this type, 35.2 per cent were cured, 41.1 per cent were improved and 23.7 per cent remained unchanged. In patients with pronounced cardiac changes the results were not as satisfactory. Especially poor results were obtained in cases of nodular and substernal struma. The impression was obtained that radiation therapy gave better results in the patients with a basal metabolism below 50 per cent than in those with a rate above 50 per cent. Similarly, better results were obtained in the patients with a pulse rate below 120 than in those with a pulse rate above 120. In regard to the individual symptoms, the following may be stated: In a predominant number of cases the tachycardia was favorably influenced. In 40 per cent of the cases the pulse rate was normal at the end of treatment, in 26 per cent it was definitely decreased and in 34.4 per cent it was either unchanged or increased. The body weight increased in 68 per cent of the cases, remained unchanged in 15 per cent and decreased in 17 per cent. In 38 per cent of the cases the basal metabolic rate became normal at the end of treatment, in 36 per cent it was decreased, in 12 per cent it was unchanged and in 14 per cent it was increased. In 45 per cent of the Basedow patients the exophthalmus disappeared, in 30 per cent it was improved and in 25 per cent it remained unchanged. A complete regression or diminution of the struma occurred in 67 per cent of the cases while in 33 per cent it remained unchanged or even enlarged slightly.

Even though better results have been reported from surgical treatment, nevertheless roentgen treatment of hyperthyreosis is of definite value in the proper cases.—*A. Schwartzman.*

Frisch, Ernst. Die funktionelle Röntgentherapie der Dysbasia arteriosklerotica intermittens. (Functional radiation therapy of intermittent arteriosclerotic dysbasia.) *Strahlentherapie*, 1939, *64*, 408–430.

The term functional roentgen therapy refers to the influence of the vegetative system by means of roentgen rays whereby the function of this nervous system is changed within certain limits and thereby a definite influence is exerted on the vegetative functions of the body.

In the course of the last ten years, repeated communications appeared in the literature regarding the results obtained from the roentgen treatment of the suprarenal region in diseases of the peripheral circulation. In some instances the symptoms resulting from an interference with the arterial blood supply have disappeared following the roentgen irradiation of the suprarenal region. A clinical evaluation of the possibilities of this therapy clearly shows that in this manner only functional improvement could be obtained. It is quite clear that roentgen therapy cannot lead to a disappearance of the pathologico-anatomical changes of the vascular wall in cases of thrombo-angiitis or arteriosclerosis. Similarly, roentgen therapy cannot lead to a disappearance of emboli and arterial thromboses.

Of the 12 cases of intermittent arteriosclerotic dysbasia treated by this author, an improvement, and in some instances an improvement of such an extent that it could be looked upon as a cure, was obtained in 10 cases by means of functional roentgen therapy, that is, by means of roentgen irradiation of the suprarenal region or of the corresponding segments of the autonomous nervous system. Two of the 3 cases of gangrene were cured. In order to obtain the best results from the functional roentgen therapy in cases of this type, one must be thoroughly familiar with the etiology, phase of the disease and factors which have a transitory influence on the intermittent claudication. This type of therapy is only functional in nature. Its side effects, namely, the decrease of the blood sugar level, the dehydration, the lowering of the blood pressure, all contribute considerably to the creation of better conditions for the body. Neither late nor contemporary injuries were observed from the method of treatment.—*A. Schwartzman.*